BSCZO- 204

B. Sc. II YEAR

PRAC TICAL ZOOLOGY

DEPARTMENT OF ZOOLOGY
SCHOOL OF SCIENCES
UTTARAKHAND OPEN UNIVERSITY

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UNIT 1 PROTOCHORDATA (STUDY OF PERMANENT SLIDE & MUSEUM SPECIMENS)

CONTENTS

General Characteristics of Chordata:-

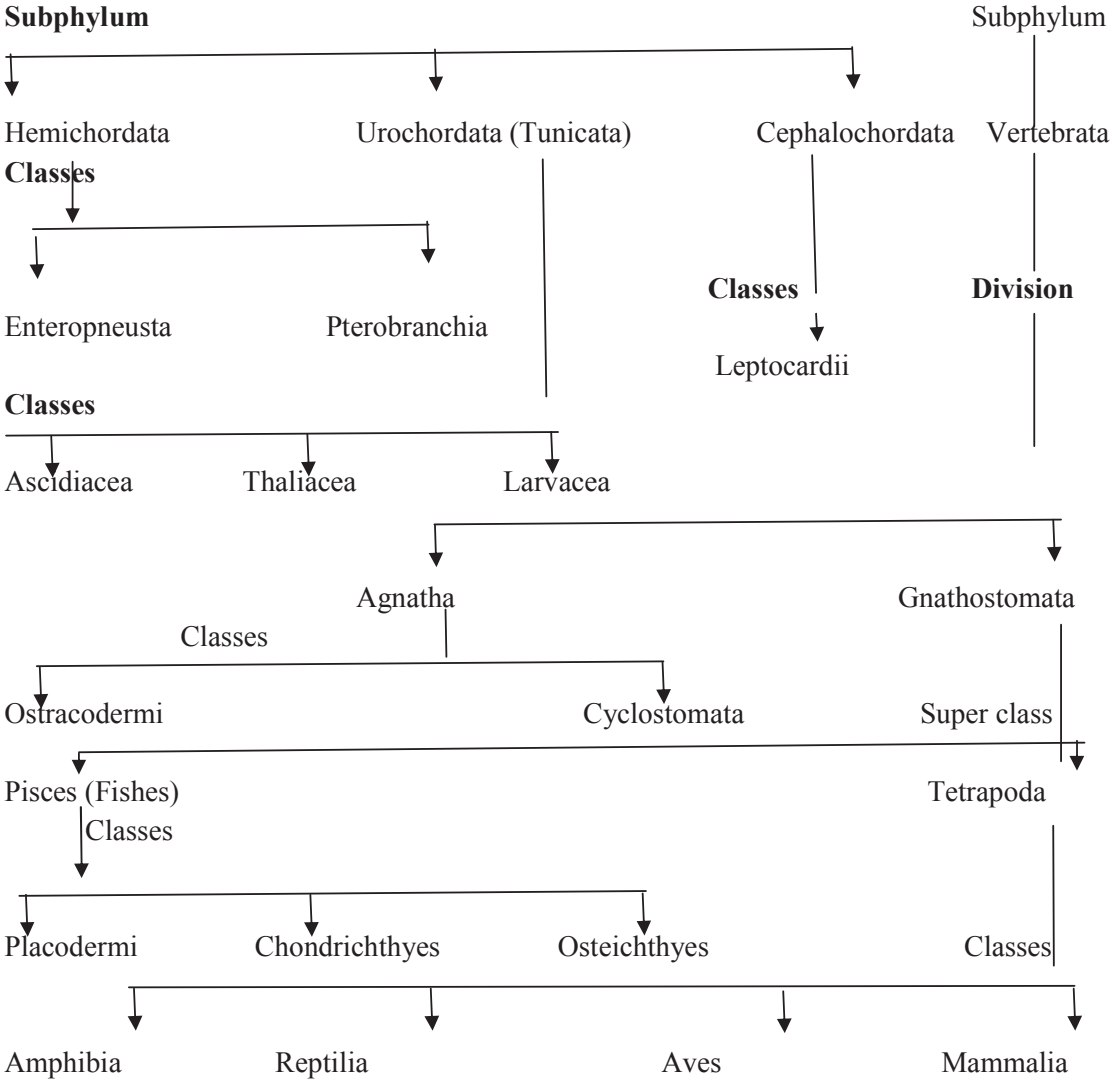
1. Bilaterally symmetrical and metamerically segmented.
2. They are triploblastic.
3. Dorsal tubular nerve cord is present.
4. Notochord (delicate, longitudinal rod of connective tissue located between nerve cord and digestive tract) is present at some stage of life. It is completely or partially replaced by vertebral column in adult.
5. Paired gill-slits are present on either side of the pharynx at some stage of life.
6. A well developed Coelom is present (Coelomate).
7. Hepatic portal system is present.
8. A post anal tail is present at some stage of life.

Classification of Phylum Chordate:-

Phylum Chordata

Group

Lower Chordata Or Acraniata Or Protochordata	Higher Chordata or Craniata
- Cranium, vertebral column & paired appendages absent. - Nerve cord, notochord & gill slits present.	- Cranium, visceral arches vertebral column & brain present. -Notochord breaks up into a series of vertebrae in subphylum **vertebrata.**


Subphylum
Subphylum
Hemichordata
Urochordata (Tunicata)
Cephalochordata
Vertebrata
Classes
Classes
Division
Enteropneusta
Pterobranchia
Leptocardii
Classes
Ascidiacea
Thaliacea
Larvacea
Agnatha
Gnathostomata
Classes
Ostracodermi
Cyclostomata
Super class
Pisces (Fishes)
Tetrapoda
Classes
Placodermi
Chondrichthyes
Osteichthyes
Classes
Amphibia
Reptilia
Aves
Mammalia

1.1 OBJECTIVES

By the end of chapter we will learn

1. The objective of this chapter is to understand the division of protochordata upto order level.

2. A detailed study of different body parts of Amphioxus and Balanoglassus**.**

3. Detailed study of some important protochordata and cyclostomata like Doliolum, Salpa, Oikopleura, Herdmania, Ciona and Balanoglossus.

1.2 INTRODUCTION

They are lower order members of phylum chordata. Th name Protochordate is derived from two words, protos =first; chorda=cord. They are of great phylogenetic significance. It shows first sign of vertebrate formation.

1.3 GENERAL CHARACTERS

1. Generally marine, found at the bottom of ocean bed.

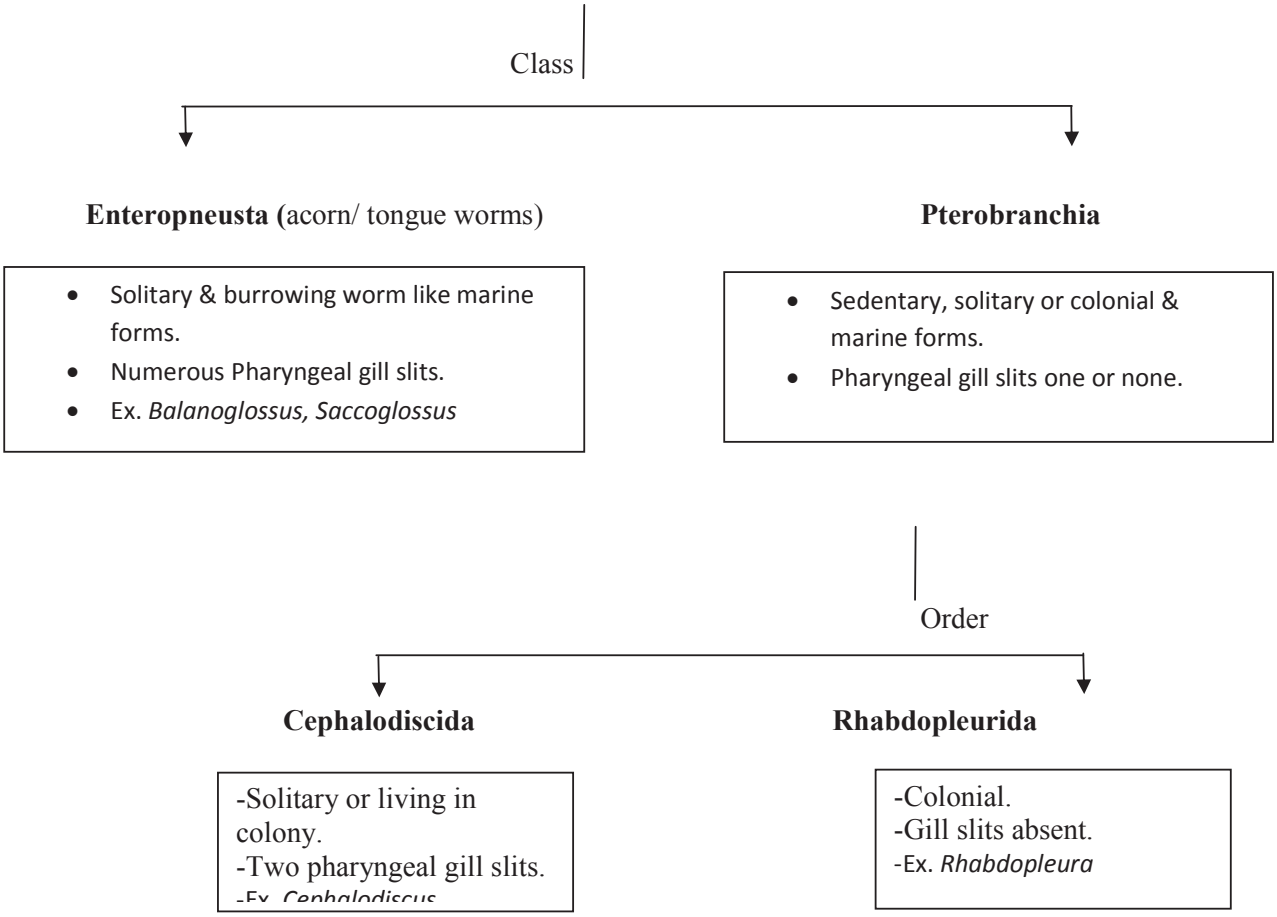
2. Presence of notochord, gill slits and dorsal nerve cord.

1.4 CLASSIFICATION UPTO ORDER LEVEL

Group: Lower Protochordata or Chordata or Acraniata

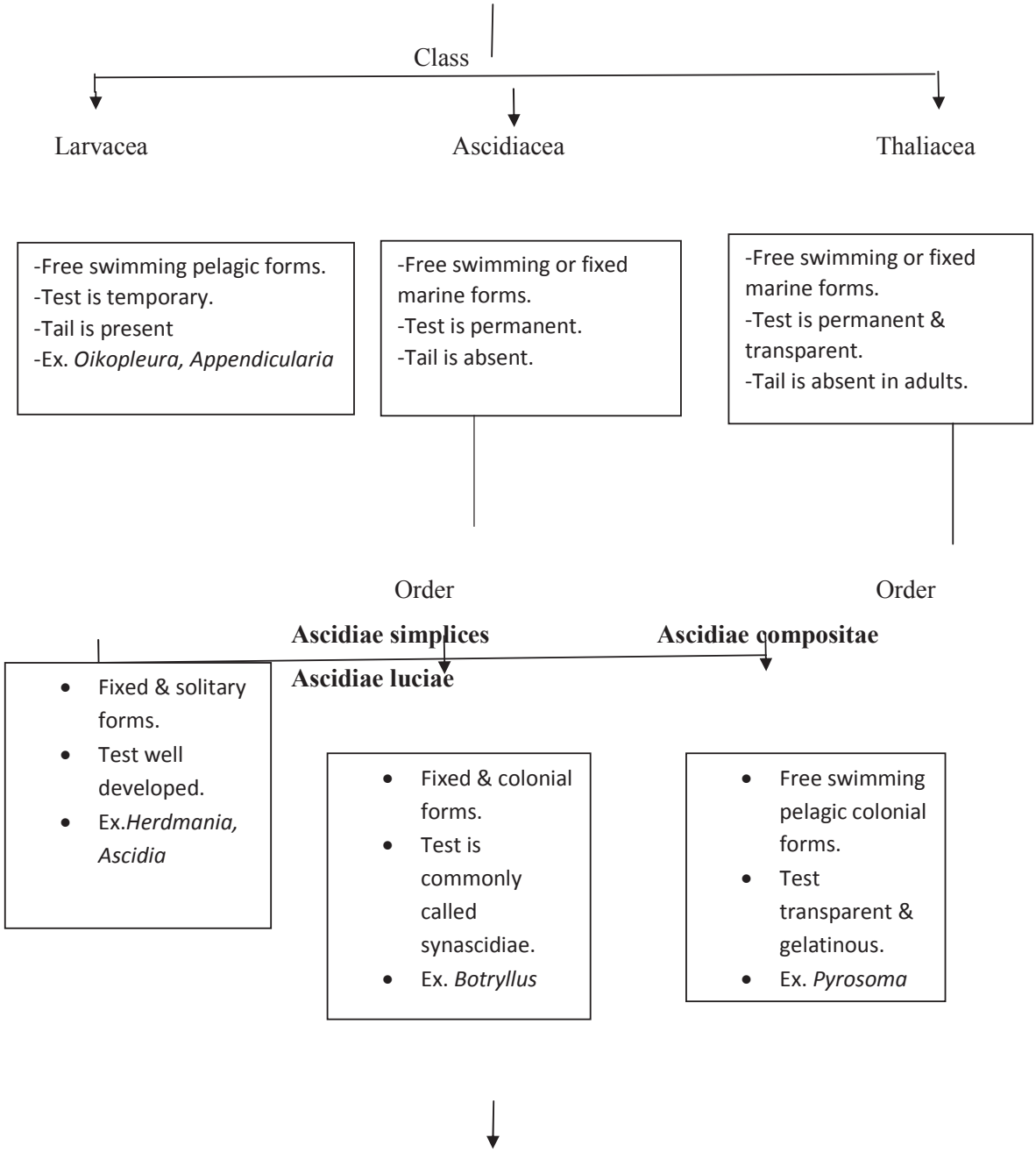
Sub-phylum-I : Hemichordata

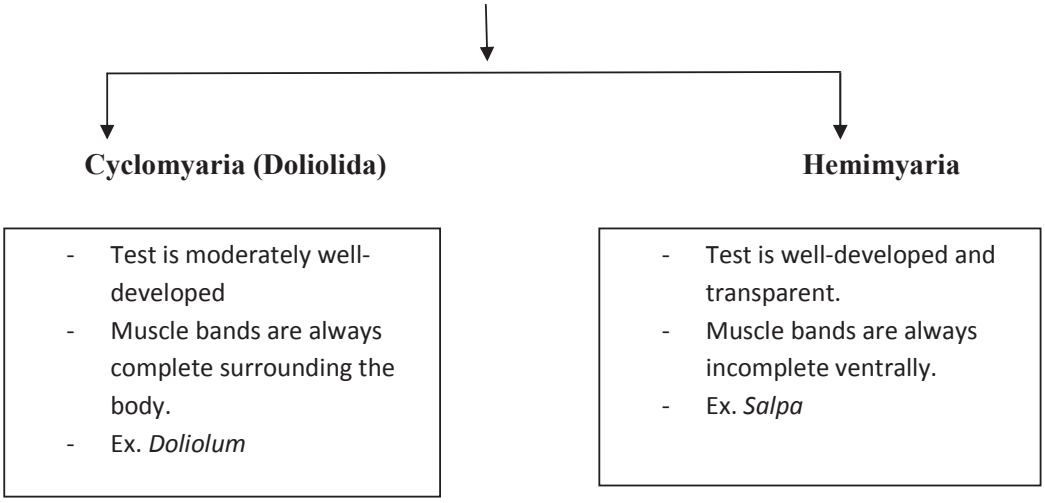
- Exclusively marine, soft bodied.
- Notochord occurs at anterior end only.
- Sexes are separate & development may be direct or indirect.



Sub-phylum-II : Urochordata (Sea squirts)

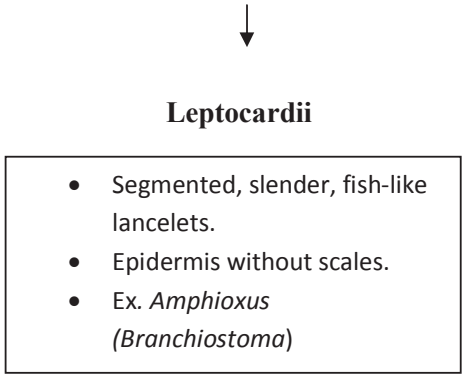
- Exclusively marine.
- Notochord present in the larval stages only.
- Sexes are united (Hermaphrodite).


Class
Larvacea
Ascidiacea
Thaliacea
-Free swimming pelagic forms.
-Test is temporary.
-Tail is present
-Ex. Oikopleura, Appendicularia
-Free swimming or fixed marine forms.
-Test is permanent.
-Tail is absent.
-Free swimming or fixed marine forms.
-Test is permanent & transparent.
-Tail is absent in adults.
Order
Order
Ascidiae simplices
Ascidiae compositae
Ascidiae luciae
Fixed & solitary forms.
Test well developed.
Ex.Herdmania, Ascidia
Fixed & colonial forms.
Test is commonly called synascidiae.
Ex. Botryllus
Free swimming pelagic colonial forms.
Test transparent & gelatinous.
Ex. Pyrosoma



Sub-phylum-III : Cephalochordata

- Exclusively marine & solitary forms.
- Notochord and nerve cord extend the entire length of the body & persist as such.
- Sexes are united (Hermaphrodite).



1.5 STUDY OF PERMANENT SLIDE

1. Amphioxus

(a) T.S of *Amphioxus* through oral hood:-

General characteristics:-

1. Body wall comprise of single layer of epidermis.
2. Dorsal fin with dorsal fin ray is presenton the dorsal surface.
3. Myotomes separated by myocommata are present on both the sides in the dorsal half portions of the section.
4. Dorsal tubular nerve cord containing ocellus lies below the dorsal fin.
5. Notochord composed of vacuolated cells and located below the nerve cord.It is enclosed in the notochordal sheath
6. The oral hood encloses a large buccal cavity.
7. Oral hood is anteriormost structure containing 10 to 11 pairs of oral cirri or buccal cirri.
8. The dorsal wall of the buccal cavity has a groove called Hatscheck's groove which is sensory in nature.

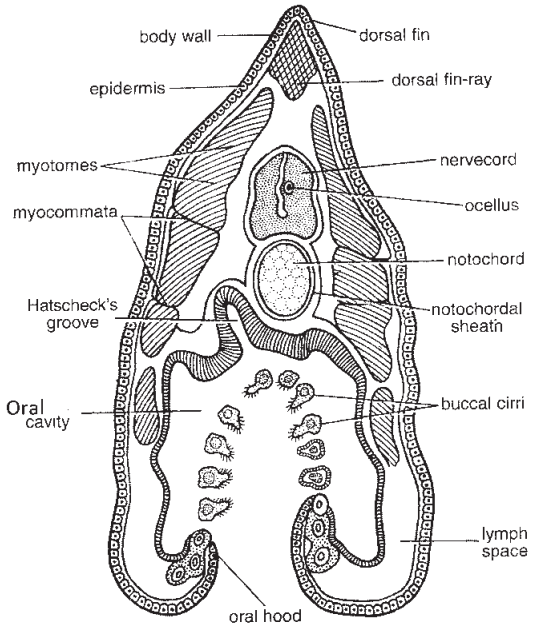


Fig. 1.1 T.S of Amphioxus through oral hood

(b) T.S of *Amphioxus* through pharynx:-

General characteristics:-

1. Body wall is formed of epidermis which is composed of a single layer of simple columnar epithelium.
2. Dorsal fin with dorsal fin ray lies at the dorsal surface.
3. Myotomes and myocommata of both the dorso-lateral sides alternate with each other.
4. Dorsal tubular nerve cord is present below the dorsal fin.
5. Notochord composed of vacuolated cells, is surrounded by notochordal sheath and lies below the nerve cord.
6. Pharynx is quite spacious and surrounded by the atrial cavity.
7. Pharynx is perforated by numerous gill slits which on either side separated by primary and secondary gill bars.
8. In the mid-dorsal line of the pharynx is present a ciliated epipharyngeal-groove, while in the mid –ventral line lies a glandular endostyle.
9. The dorsal aortae are present, one on either side of the epipharyngeal groove.
10. The coelom appears as dorsal coelomic canals on either side of the epipharyngeal groove. Parts of coelom are also present in the endostyle and in metapleural folds.
11. The metapleural folds are present on the ventral side.

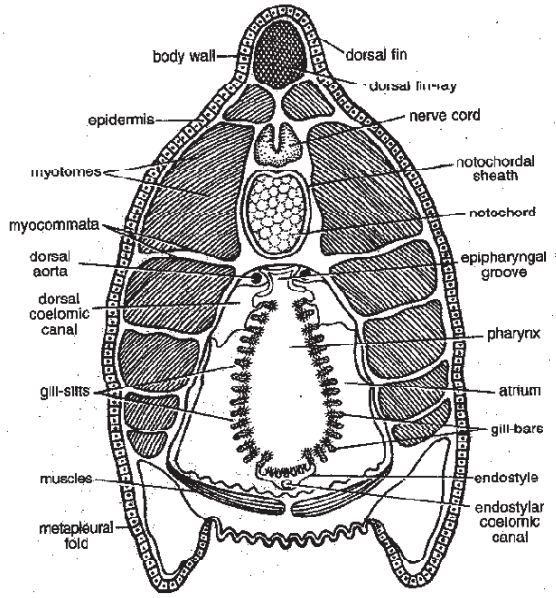


Fig. 1.2 T.S of Amphioxus through pharynx

(c) **T.S of *Amphioxus* through testes:-**

General characteristics:-

1. Body wall is formed of epidermis which is composed of single layer of simple columnar epithelium.
2. Dorsal fin having the dorsal fin ray is present on the dorsal surface.
3. Myotomes separated by myocommata are present on both the sides.
4. Nerve cord contains a central canal and lies below the dorsal fin ray.
5. Notochord composed of vacuolated cells and surrounded by notochordal sheath, lies below the nerve cord.
6. Pharynx is quite spacious occupying the most of the spaces between the notochord and the metapleural folds.
7. Pharynx is perforated by numerous gill-slits.
8. In the mid- dorsal line of pharynx lies a ciliated epipharyngeal-groove, while in the mid-ventral line is present a glandular ciliated endostyle.
9. Two dorsal aortae are present, one on the either side of the epipharyngeal groove.
10. The atrium is present around the pharynx.

11. The coelom appears as dorsal coelomic canals on either side of the epipharyngeal groove. Parts of coelom are also present in the endostyle, in metapleural folds and around the liver diverticulum and gonads.
12. Liver diverticulum lies on the the right side of the pharynx.
13. Testes, one pair in section lies in the atrium on both the sides of the pharynx.
14. Testes contain several spermatozoa.
15. Two metapleural folds are present on both the sides.

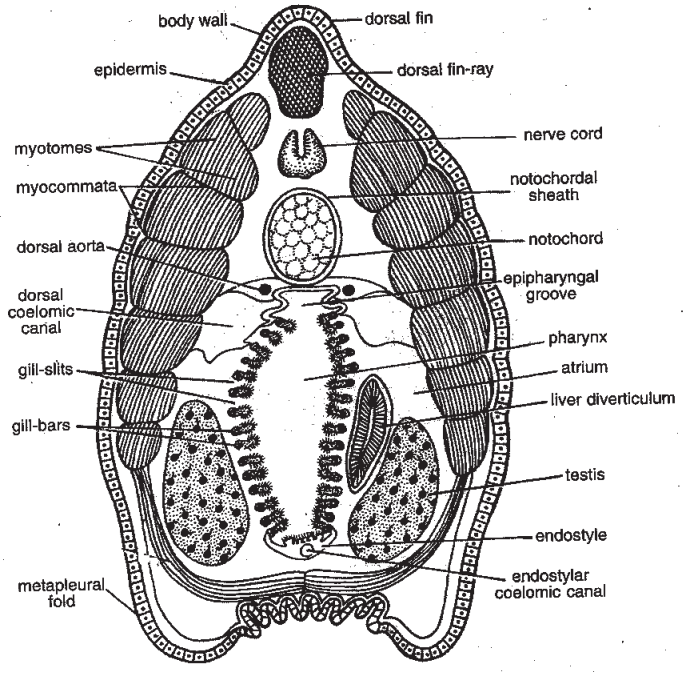


Fig. 1.3 T.S of Amphioxus through testes

(d) **T.S of *Amphioxus* through ovaries:-**

General characteristics:-

1. Body wall is formed of epidermis which is composed of single layer of simple columnar epithelium.
2. Dorsal fin having the dorsal fin ray is present on the dorsal surface.
3. Myotomes separated by myocommata are present on both the sides.
4. Nerve cord contains a central canal and lies below the dorsal fin ray.

5. Notochord composed of vacuolated cells and surrounded by notochordal sheath, lies below the nerve cord.
6. Pharynx is quite spacious occupying the most of the spaces between the notochord and the metapleural folds.
7. Pharynx is perforated by numerous gill-slits.
8. In the mid- dorsal line of pharynx lies a ciliated epipharyngealgroove, while in the mid-ventral line is present a glandular ciliated endostyle.
9. Two dorsal aortae are present, one on the either side of the epipharyngeal groove.
10. The atrium is present around the pharynx.
11. The coelom appears as dorsal coelomic canals on either side of the epipharyngeal groove. Parts of coelom are also present in the endostyle, in metapleural folds and around the liver diverticulum and gonads.
12. Liver diverticulum lies on the right side of the pharynx.
13. Ovaries contain several ova.
14. Two metapleural folds are present on both the sides.

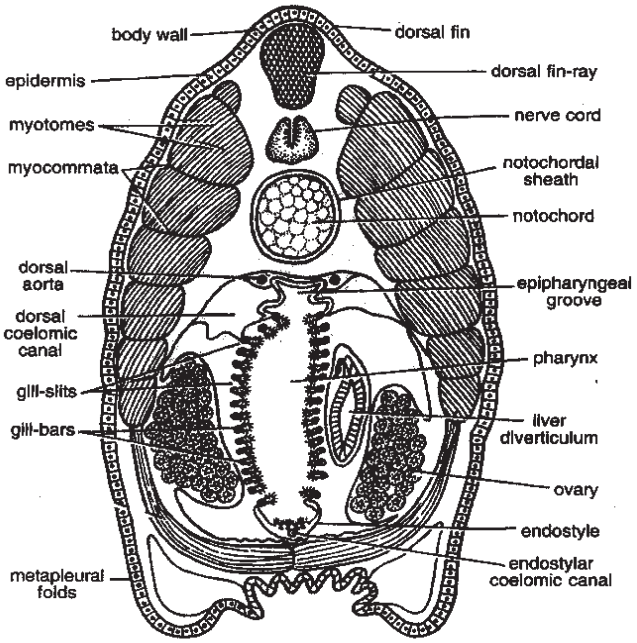


Fig. 1.4 T.S of Amphioxus through ovaries

(e) Velum of *Amphioxus*(Whole mount)

General characteristics:-

1. Velum of *Amphioxus* is a vertical transverse partition lying at the posterior wall of the vestibule or buccal cavity or oral cavity.
2. It is composed of velar ring, sphincter and velar-tentacles.
3. The velar ring is quite a thick layer around the velar tentacles.
4. The sphincter composed of circular muscle fibres and controls the working of velar – tentacles.
5. The sphincter having sensory papillae are 10-12 in number arising from the velar ring and projecting into the enterostome.
6. The enterostome is the opening of the velum in the vestibule.
7. The velum acts as a sieve in the filteration of food particles.

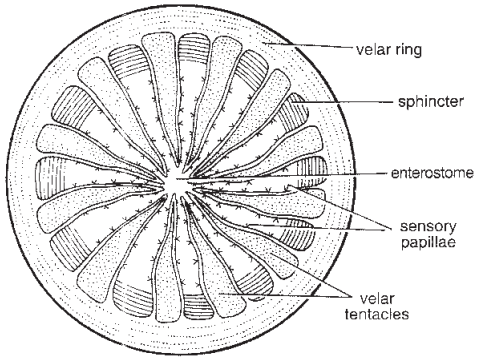


Fig. 1.5 Velum of Amphioxus (Whole mount)

(f) Oral Hood of *Amphioxus*(Whole Worm)

General characteristics:-

1. The oral hood guards the buccal cavity or vestibule of *Ampioxus*.
2. It is composed of numerous oral cirri and a central cavity.
3. The oral cirri are long, processes, 10-12 in number arising from the wall of the vestibule.
4. Each oral cirrus contains a skeletal-rod and bears small sensory papillae on its outer surface.
5. The vestibule is thick and muscular.

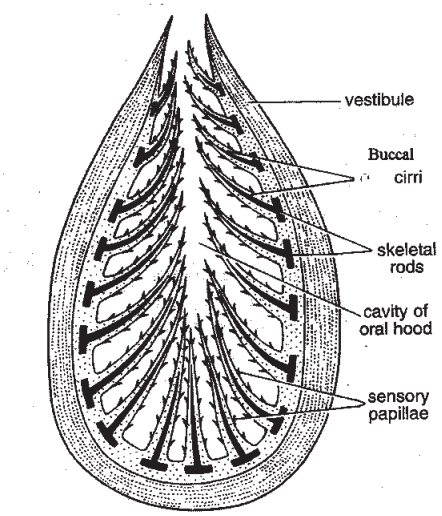


Fig. 1.6 Oral Hood of Amphioxus (Whole Worm)

2. *Balanoglossus*

(a) T.S of proboscis of *Balanoglossus*:-

General characteristics:-

1. Body wall is composed of single layer of epidermis.
2. Nervous layer lies below epidermis.
3. Basement membrane is present just below the nervous layer.
4. Proboscis coelom is very much reduced.
5. Central complex comprises of the buccal diverticulum, glomerulus, central sinus and heart vesicle.

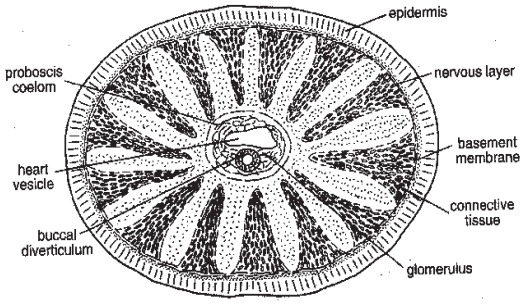


Fig. 1.7 T.S of proboscis of Balanoglossus

(b) T.S of collar of *Balanoglossus*:-

General characteristics:-

1. Body wall is composed of epidermis.
2. Epidermis is provided with blood plexus on its inner side.
3. Collar coelom lies just below epidermis.
4. Collar coelom is divided into two parts
   (i) Dorsal and
   (ii) Ventral mesenteries.
5. Collar coelom is filled by the connective tissue.
6. A collar cord, dorsal blood vessel, two collar canals and two perihaemal spaces are seenin dorsal portion
7. Ventral blood vessel lies above the ventral mesentery.
8. Circular muscle fibres form a layer lining the collar coelom.
9. Spacious buccal cavity is present in the centre & it is lined with coelomic epithelium.

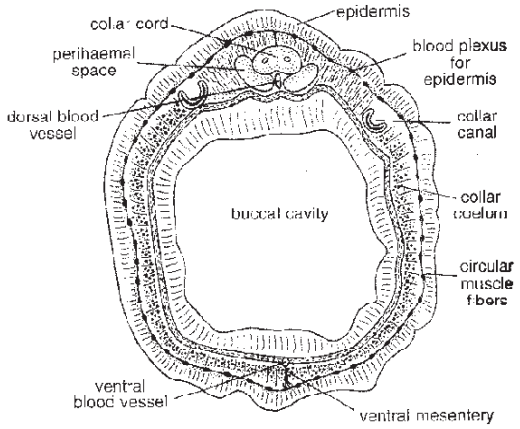


Fig. 1.8 T.S of collar of Balanoglossus

(c) T.S of branchiogenital region of *Balanoglossus*

General characteristics:-

1. Outer layer of skin is without distinction of epidermis and dermis.
2. Musculature and connective tissue are lies beneath the epidermis.
3. A pair of genital wings is present.
4. The genital wings contain numerous gonads arranged in series along its inner lining and blood vessels.

5. Pharynx is seen in the centre.
6. Phraynx is divided into two parts-
   (i) Upper branchial or respiratory pharynx and
   (ii) lower portion the digestive pharynx
7. The respiratory pharynx communicates to the outer side by lateral branchial aperture.
8. Gonads are lined with epithelium.
9. Two branchial vessels are seen at the junction of branchial pharynx and digestive pharynx.
10. Muscle fibres are seen scattered throughout the genital wings and pharyngeal region.

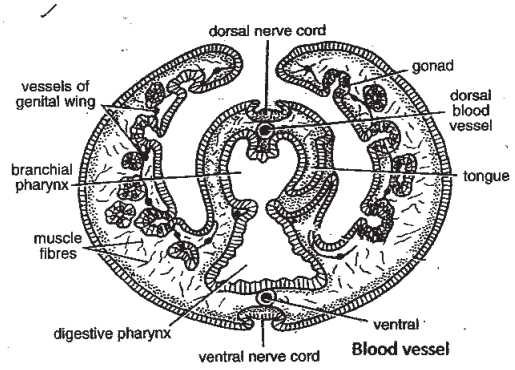


Fig. 1.9 T.S of branchiogenital region of Balanoglossus

(d) Tornaria larva(Whole mount)

General characteristics:-

1. Tornaria larva is ovoid in shape and is extremely transparent.
2. Their size varies from one millimeter to 9 millimeter.
3. It is provided with two ciliated bands.
   (i) A pre-oral ciliated band forms a post-oral ring or loop
   (ii) A posterior ciliated band or circum-anal ring
4. At its anterior end is an apical plate (thickened plate) which bears a tuft of cilia and a pair of pigmented eye-spots.
5. The mouth is situated on the ventral surface, while anus lies at the posterior terminal end.
6. The alimentary canal is simple having a mouth, oesphagus, stomach and intestine.

7. A water sac is also found in the body of larva which opens out side through the dorsal pore,(hydropore).
8. The oral bands help in nutrition by directing the water currents towards the mouth.
9. The circum anal ring, regarded by some as a telotroch, develops especially long and powerful cilia and is the chief locomotory organ of Tornaria.
10. The tornaria larva resembles the echinoderm larvae.
11. It attains adult form after undergoing metamorphoses.

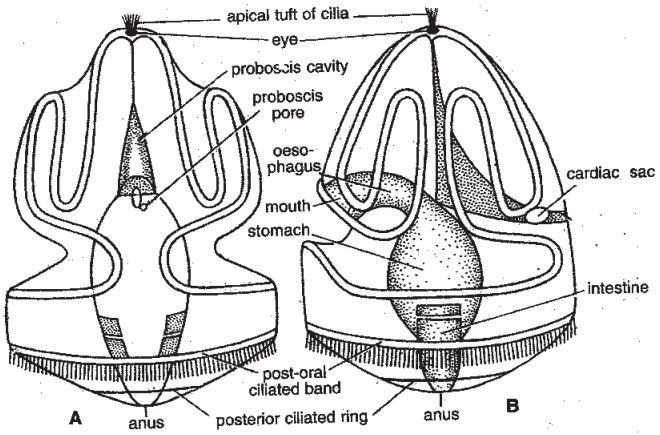


Fig. 1.10 Tornaria larvas (Whole mount)

(A) Dorsal (B) Ventral

3. Doliolum

General characters:-

1. *Doliolum* is found in marine water, a free swimming, pelagic form inhabiting the warm water.
2. Its body is barrel shaped with mouth and anus at opposite ends.
3. Tunic is thin, transparent and contains no cells.
4. It shows polymorphism and exist in two phases

(i) Sexual phase (Gonozooid)

(ii) Asexual phase (Oozoid)

(i) Sexual phase (Gonozooid)

1. The mouth is surrounded by 12 branchial lobes and atrial aperture is surrounded by 10 atrial lobes.
2. The oral funnel opens broadly into the voluminous pharynx.
3. Pharynx is perforated by dorsal and ventral rows of stigmata.
4. Pharynx also bears ventral endostyle and pharyngeal ciliated bands.
5. Endostyle and peripharyngeal ciliated bands are present in the pharynx.
6. Dorsal lamina and tentacles are absent.
7. Small stomach and short intestine and the anus opens almost posteriorly.
8. Heart and nervous system are present in both forms.
9. Dorsal ganglion and subneural glands are situated near the anterior end.
10. They are hermaphrodite.

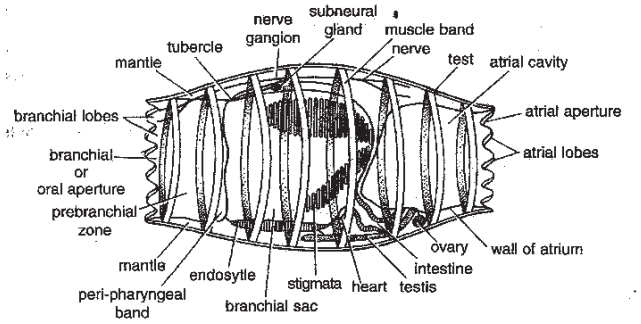


Fig 1.11 Doliolum (Sexual phase)

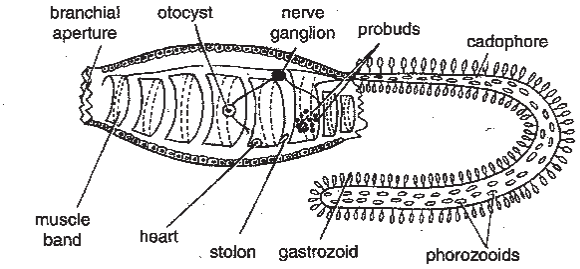


Fig 1.12 Doliolum (Asexual phase)

(ii) Asexual phase (Oozooid)

1. It possesses nine circular muscular bands.
2. Otocyst is present.
3. Alimentary canal atrophied.
4. Asexual form reproduces by budding & gives rise to gastrozooid & phorozooids.
5. Phorozooid develop on cadophore and buds develop on stolon.

Systematic Position:

Phylum : Chordata ---Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata/ acraniata --- Marine and small forms . Cranium jaws and paired appendages are absent.

Subphylum : Urochordata ---Solitary or colonial , fixed or free swimming with cuticular test containing tunicin .

Class : Thaliacea --- Free swimming pelagic, solitary or colonial. Muscles in form of circular bands.

Order : Doliolida --- complete ring of muscle band

Genus : *Doliolum*

4. Salpa

General characters:-

1. *Salpa* is found in tropical seas. It is free swimming, solitary pelagic form.
2. *Salpa* exhibits polymorphism and exists in two phases-
   (i) Asexual phase (Oozooid) (ii) sexual phase Blastozooid

(i) Asexual phase (Oozooid):-

1. Body is barrel shaped with mouth and atrial apertures are on opposite ends.
2. Test is transparent.

3. Endostyle and pharyngeal bands are present.
4. Dorsal tentacle is present on the dorsal surface.
5. Single tentacle is present on the dorsal surface.
6. Digestive system and heart are present in a spot named as nucleus.
7. Eyes are present near the nerve ganglion.
8. Dorsal tubercle is present in front of the pharynx.
9. Sub neural gland is present ventral to the ganglion.

(ii) Sexual phase (Blastozooid):-

1. Hermaphrodite.
2. Ovary and paired testes mature at different times.
3. Development direct.
4. Embryo develops into an asexual form and separate from the parent.

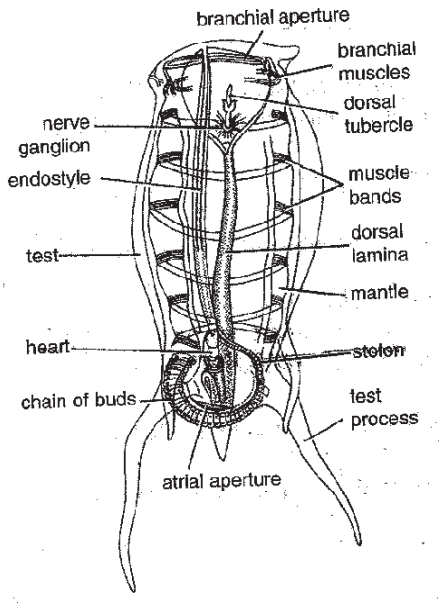


Fig. 1.13 Salpa Asexual phase (Oozooid)

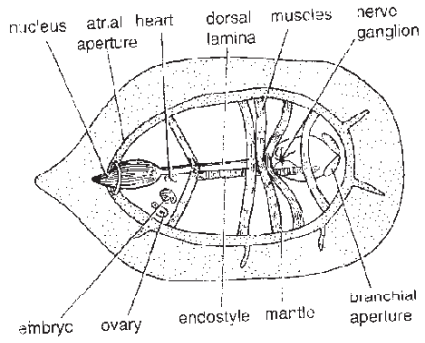


Fig. 1.14 Sexual phase (Blastozooid)

Systematic position:

Phylum : Chordata ---Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata --- Marine and small forms . Cranium, jaws and paired appendages are absent.

Subphylum: Urochordata --- Solitary or colonial , fixed or free swimming with cuticular test containing tunicin .

Class : Thaliacea ---Free swimming pelagic, solitary or colonial. Muscles in form of circular bands.

Order : Salpida

Genus : *Salpa*

***5. Oikopleura*:-**

Comments:

1. *Oikopleura* lives in a test or house in which it can move about freely.
2. They are tiny, solitary, free swimming and of pelagic form.
3. Tail is long with a fin, lies at an angle to the body and acts like a locomotory appendage.
4. Notochord lies within tail.
5. Pharynx has two gill-slits or stigmata which opens to the exterior.
6. Endostyle and peripharyngeal bands are present.
7. Dorsal lamina is absent.
8. U shaped alimentary canal is present.

9. 7-12 striped muscle cells are present.
10. Dorsal nerve cord extends throughout the length of the body and also in tail.
11. Nerve ganglion and otocyst present.
12. They are hermaphrodite
13. Exhibits neoteny.

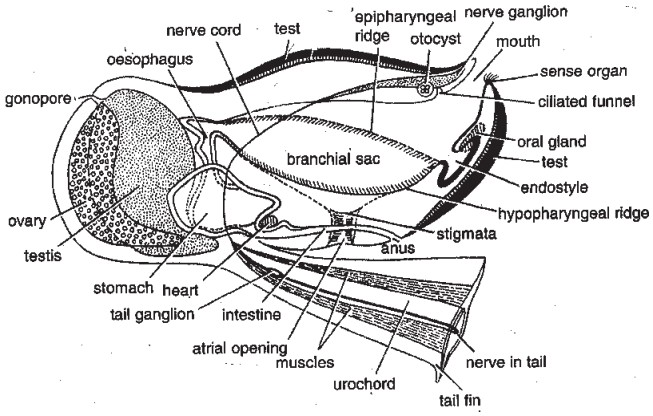


Fig. 1.15 Oikopleura

Systematic position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata --- Marine and small forms . Cranium jaws and paired appendages are absent.

Subphylum : Urochordata --- Solitary or colonial , fixed or free swimming with cuticular test containing tunicin .

Class : Larvaccea --- Neotenic pelagic forms with temporary test.

Genus : *Oikopleura*

1.6 MUSEUM SPECIMEN

1. *Herdmania* (Sea squirt):-

General characters:-

1. *Herdmania* lives a solitary marine life.
2. They attached with the surface of ocean by a foot through its posterior ventral ends.
3. Body is roughly oblong enclosed in a soft leathery test.
4. Color of the body is pink.
5. Free ends of the body are providing with two external openings of the branchial and the atrial aperatures.
6. Mouth opens by branchial aperature or siphon while anus by atrial aperature.
7. Pharynx is sac like perforated by numerous stigmata.
8. Alimentary canal is U shaped.
9. Respiration is through branchial – sac. They also have accessory respiratory organs in the form of test.
10. Blood vascular system is open type.
11. Execretory organ is neural gland situated above the nerve ganglion.
12. Sexes are united or hermaphroditic.
13. Fertilization external & development is indirect.

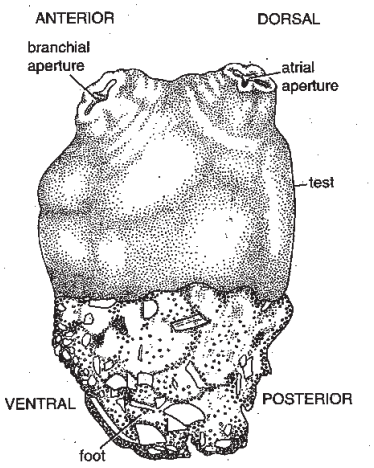


Fig. 1.16 Herdmania (Sea squirt)

Systematic position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata --- Marine and small forms . Cranium jaws and paired appendages are absent.

Subphylum: Urochordata --- Solitary or colonial ,fixed or free swimming with cuticular test containing tunicin . Notochord at tail region of larval stage

Class : Ascidiacea --- Well developed and permanent test. Branchial sac large perforated by numerous gill- slits .

Order : Enterogona --- Neural gland ventral to nerve ganglion.

Genus : *Herdmania*

2. *Ciona*

General characters:

1. *Ciona* is a solitary animal
2. Their body is cylindrical, tubular, and transparent.
3. They reach a length of 3.5 to 5 inches.
4. Their body is covered by a thin transparent test or mantle.
5. Mouth opens into branchial siphon and anus into atrial siphon.
6. Branchial aperture is 8 lobbed and atrial aperature is 6 lobbed.
7. Pharynx without longitudinal folds.
8. Alimentary canal is U shaped and consists of pharynx, oesophagus, stomach and intestine.
9. Stigmata are rectangular.
10. Dorsal tubercle is horse shoe shaped.
11. They are Hermaphroditic and protogynous.

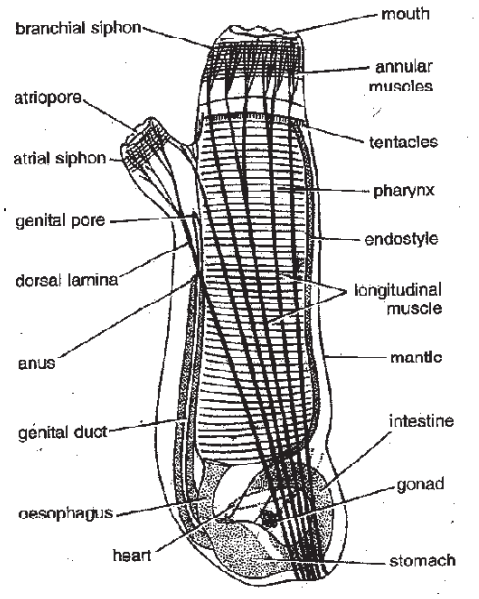


Fig. 1.17 Ciona

Systematic position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata --- Marine and small forms . Cranium, jaws and paired appendages are absent.

Subphylum : Urochordata --- Solitary or colonial , fixed or free swimming with cuticular test containing tunicin.

Class : Ascidiacea --- Well developed and permanent test. Branchial sac large perforated by numerous gill- slits .

Order : Enterogona --- Neural gland ventral to nerve ganglion.

Genus : *Ciona*

***3. Balanoglossus* (acorn worm):**

Comments:

1. *Balanoglossus* is found in marine water.
2. They live at the surface of marine water.
3. Their body is soft and cylindrical having ciliated surface. Length is about 10-50 cm.
4. Body is divided into short conical proboscis, collar and a long trunk.
5. **Proboscis** has thick muscular walls and its cavity –proboscis coelom opens to the outside by a proboscis pore.
6. **Collar** is short, muscular cylinder like, enclosing a pair of coelomic cavities open to the dorsal surface by a pair of collar pores.
7. **Trunk** is devoid of segmentation (superficially ringed).
8. Trunk is divisible into anterior branchio-genital region, middle hepatic region and a posterior abdominal region.
9. Alimentary canal is straight and anus is present on the posterior end of the body.
10. Sexes are separate and fertilization is external. Development is indirect.
11. The life cycle comprise of a free – swimming pelagic larva, the tornaria.

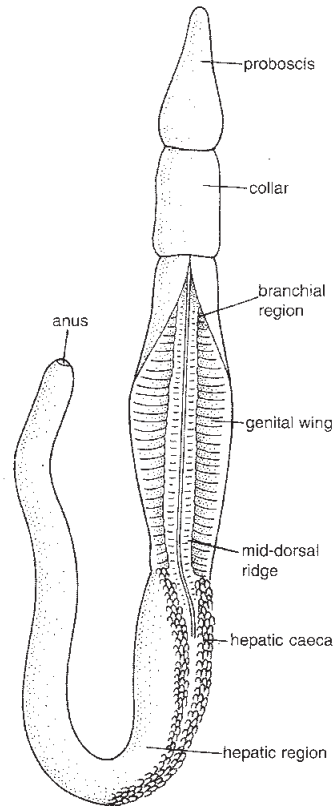


Fig.1.18 Balanoglossus

Systematic position:

Phylum : Chordata - Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Protochordata - Marine and small forms. Cranium, Jaws and paired appendages are absent.

Subphylum : Hemichordata - Solitary, soft-boiled, coelomate with numerous gill – slits.

Class : Enteropneusta - Alimentary canal straight, two rows of caeca.

Genus : *Balanoglossus*

1.7 CYCLOSTOMATA

General characteristics:-

1. Body is long, rounded and eel like. Found in marine water
2. Skin is soft, smooth and without exoskeleton.
3. Mouth is suctorial devoid of functional jaws.
4. Paired fins or lateral appendages are absent.
5. Skeleton is cartilaginous.
6. Notochord is persistant.
7. Heart is two chambered with many aortic arches.
8. Development is direct or indirect.

1. *Petromyzon* (lamprey/ lamper eel):

General characters:-

1. They are found in both fresh water and salty water.
2. They are ecto -parasite on fishes.
3. Body is divided into head, trunk and tail. Length is about 1 meter.
4. Surface of body is smooth and slimy and heavily pigmented.
5. Head region is characterized by great forward development of the upper lip region forming the buccal funnel.
6. Mouth is circular armed with numerous horny teeth.
7. The paired eyes are relatively large and functional.
8. There are two small median eyes-pineal and parietal.
9. Nostril is single and dorsal.
10. Seven pairs of external gill- apertures and well developed cartilaginous rays.
11. Jaws and paired fins are absent.
12. Sexes are separate. Female has large anal fin and male with urinogenital or copulatory papilla.
13. Fertilization is external. Development is indirect includes Ammocoete larva.

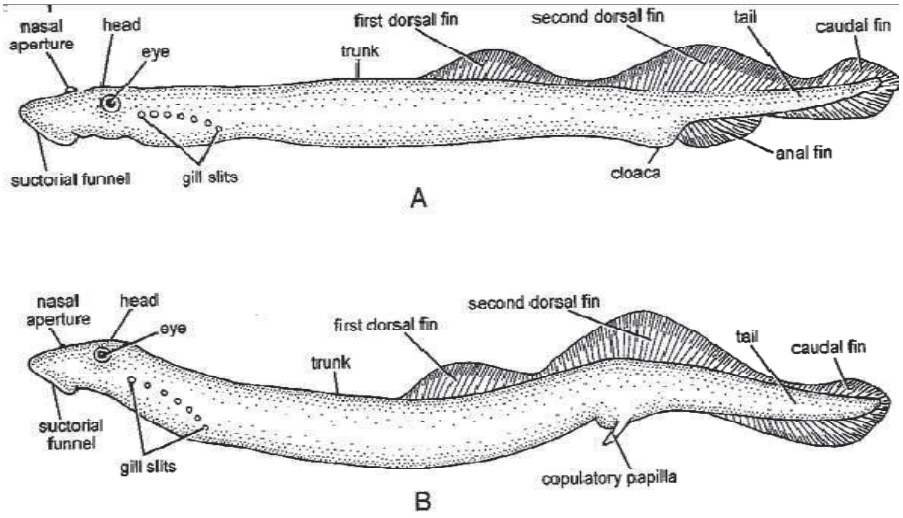


Fig.1.19Petromyzon (A) Female (B) Male

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Vertebrata --- Notochord is replaced by vertebral columns; two pairs of appendages; circulatory system closed , blood containing R.B.C.

Subphylum : Agnatha --- Jaws and appendages are absent.

Class : Cyclostomata --- Mouth suctorial devoid of functional jaws.

Order : Petromyzontia --- Well-developed dorsal fin, complete branchial-basket.

Genus : *Petromyzon*

Species : *marinus*

2. *Myxine* (Hag fish or Borer):

General characteristics:-

1. Body is eel like divided into head, trunk and tail.
2. Surface of the body is soft and smooth without scales.
3. Mouth is terminal and surrounded by soft lips.
4. Buccal funnel and jaws are absent. Branchial-basket is also reduced.

5. Lateral to the mouth are four pairs of short tentacle supported by skeletal rods.
6. Nostril is single, lies close to mouth and opens terminally.
7. Single pineal eye is visible on top of head.
8. Paired eyes are vestigial or degenerated due to dark & bottom dwelling habbit.
9. 6-14 pairs of gills which do not open separately to the outside but open by a single external gill- opening.
10. Single median fin runs from about the middle of the ventral surface extending around the tail region.
11. Large mucous glands are present opening by mucous pores.
12. They are Hermaphroditic.
13. They are parasitic or quasi – parasitic.
14. They are nocturnal and scavenger.

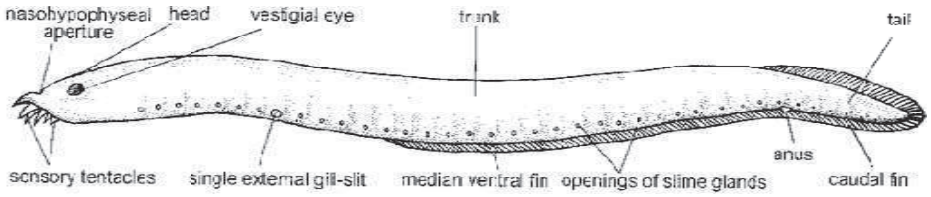


Fig. 1.20 Myxine

Systematic position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Vertebrata --- Notochord is replaced by vertebral columns; two pairs of appendages; circulatory system closed , blood containing R.B.C.

Subphylum : Agnatha --- Jaws and appendages are absent.

Class : Cyclostomata --- Mouth suctorial devoid of functional jaws.

Order : Myxinoidea --- dorsal fin absent, branchial basket reduced.

Genus : *Myxine*

Species : *glutinosa*

1.8 *SUMMARY*

Phylum chordata has been divided into two groups: Acraniata (Protochordata) and Craniata(Euchordata). Acranion (Gk- a=absent; kranion=head or protos = first; chorde = cord). Protochordata forms lower chordata includes soft-bodied without vertebrat animals such as Balanoglossus, Herdmania, Ciona, Salpa etc. It is divided into three subphylum: Hemichordata, Urochordata and Cephalochordata, based upon presence of notochord with about 2,000 species.

All species are marine with no cranium, vertebral column and jaw.Appendages, head and exoskeleton absent.

Hemichordata can be divided into two classes, Enteropneusta and Pterobranchia. Urochordata into three classes Ascidiacea, Thaliacea and Larvacea and Cephalochordata has one class Leptocardii.

Class Enteropneusta includes worm-like animals with straight alimentary canal and numerous gill-slits. Members of class Pterobranchia have a U shaped alimentary canal with one pair of gill slits.

Members of class Ascidiacea are better known as "sea squirts;" They have many gill slits, tunic well developed.

Member of Class Thaliacea are knowns as Salps. They are found in free swimming or pelagic form with circular muscle bands in tunic.

Members of class Leptocardii have fish like body with numerous gill- slits. They have burrowing habit.

Balanoglossus is burrowing marine protochordate. It is found in shallow water along the coast of warm and temperate oceans. Body is soft, elongated, and bilaterally symmetrical, with ciliated all over. Body is divided into three regions proboscis, collar and trunk. Proboscis form anterior part of body. Collar is short cylinderical lying posterior to proboscis. Trunk is the posterior part of body.

Protochordata are of little economic importance. They are of great phylogenetic significance. Three basic chordate features (notochord, hollow dorsal nerve cord and, pharyngeal gill- slits) are present.

1.9 *GLOSSARY*

Ammocoete: Larval stage of lamprey

Atrium: Heart chamber or cavity; to the specialized outer cavity of *Amphioxus*

Branchial: Pertaining to gills

Coelom: Body cavity in triploblastic animal

Dorsal: Pertaining to back.

Ectoparasite: A parasite living outside the body of host

Endostyle: Ciliated groove in the ventral surface of the pharynx in protochordates.

Gonads: Reproductive organs either ovary or testis

Hepatic: Pertaining to liver

Hermaphrodite: Possession of both male and female reproductive organ in an individual organism.

Metameres: Certain structure (Segment) which resembles each other are repeated regularly one after another.

Metamerically: Animal having a series of repeated metameres (segments or somites)**.**

Metamorphosis: Change of form during development from larva to adult animal

Neoteny: Indefinite prolongation of larval stage – adult like condition of an animal

Notochord: Rod like cellular skeletal axis found in chordate embryo or adult, mid-ventral to nerve cord.

Ocellus: A type of simple eye common to invertebrates consisting of retinal cells, pigment and nerve fibers.

Pelagic: Living or occurring in open sea.

Polymorphism: Occurrence of different forms among the members of a population or colony.

Proboscis: Tubular extension of the nose, lips or pharynx.

Protogynous: A state in hermaphroditic system in which female reproductive organs mature before male reproductive organ.

Triploblastic: Derived from 3 embryonic germ layer- ectoderm, endoderm and mesoderm.

1.10 SELF ASSESSMENT QUESTION

1. Most important feature of chordates is the presence of

(a) Notochord (b) Coelom (c) Vertebral column (d) Post anal tail

2. Notochord is made up of

(a) Bone (b) Cartilage (c) Vacuolated cells (d) Muscle fibres

3. Which of the following has notochord in tail region

(a) *Herdmania* (b) *Amphioxus* (c) *Balanoglossus* (d) *Salpa*

4. Which of the following posses all chordate characteristics at larval stage but are absent in adult stage.

(a) Herdmania (b) *Petromyzon* (c) *Amphioxus* (d) *Oikopleura*

5. Which one of the following is different?

(a) Human (b) Bat (c) Amphioxus (d) Sword Fish

6. Circulatory system of Amphioxus is unique because:

(a) Blood corpuscles are absent (b) Blood is colourless (c) Heart is absent (d) All

7. Which of the following characteristics is missing in hagfishes?

(a) Pineal eye (b) Urinogenital sinus (c) Choroid plexus (d) All

8. Thread cell are found in

(a) *Petromyzon* (b) *Myxine* (c) *Oikopleura* (d) *Pyrosoma*

9. Two sense organs are present in larva of

(a) *Herdmania* (b) *Ciona* (c) *Amphioxus* (d) *Oikopleura*

10. Which one of the following leads an ectoparasitic life?

(a) *Herdmania* (b) *Petromyzon* (c) *Amphioxus* (d) *Oikopleura*

11. Which of the following Animal acts as a connecting link between Echinoderms and Chordates is

(a) *Herdmania* (b) *Petromyzon* (c) *Amphioxus* (d) *Oikopleura*

12. *Amphioxus* lacks

(a) Heart (b) Liver (c) Atrium (d) Solenocytes

13. Suctorial mouth is present in

(a) *Herdmania* (b) *Petromyzon* (c) *Amphioxus* (d) *Oikopleura*

14. Which one of the following has a circulatory system but no heart?

(a) *Herdmania* (b) *Petromyzon* (c) *Amphioxus* (d) *Oikopleura*

15. Adult *Herdmania* lacks which of the following

(a) Notochord (b) Dorsal tubular nerve cord (c) Tail (d) All

16. Which of the following is not correct about oozoid of *Doliolum?*

(a) Barrel shaped (b) Gonads are present (c) Few large gill slits are present (d) posses 9 muscle bands

Answer

1(a) 2(c) 3(c) 4(a) 5(c) 6(d) 7(d) 8(b) 9(b) 10(b) 11(d) 12(b) 13(b) 14(c) 15(d) 16(b)

1.11 *REFERENCES*

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- **Lal, S. S. (2015)**: Practical Zoology Vertebrate. Rastogi Publications. Merrut.
- **Pandey, B**.N. (2015): Animal diversity volume 1, Tata McGraw Hill Education Private Limited.

1.12 SUGGESTED READING

- Cleveland Hickman, Jr. and Larry Roberts &Susan Keen and Allan Larson and David Eisenhour (2015): Animal diversity, 7th edition, McGraw Hill Education Private Limited, 2015.

1.13 TERMINAL QUESTION/ANSWER

1. Why *Herdmania* is known as sea squirt

   Herdmania emits a jet of water through both of its aperatures – the branchial aperature and atrial aperature.
2. Why Hag fish is not considered as vertebrates

   Notochord is reduced.
3. Why *Amphioxus* is commonly called lancelet

   They are called because of their short and tapered body.
4. Why body of Hag Fish is soft?

   Hag Fish body lacks scales but mucous glands are present on the skin.
5. Why Hag Fish are called scavengers of the sea?

   Hag Fish feeds on dead and decaying animals deposited on the surface of ocean.

UNIT 2: PISCES (FISHES)

CONTENTS

2.1 OBJECTIVES

By the end of this chapter, you will know

1. General characteristics of Pisces.
2. Classification up to order level.
3. Model on general anatomy, branchial arteries, and carnial nerves of scoliodon.
4. Histological slides of Scoliodon.
5. Study of shark skeleton.
6. Museum specimen of Pisces.

2.2 INTRODUCTION

Fishes are vertebrates within class Pisces. The word pisces has (come from the Latin word Pisces meaning "fish".They are cold blooded, lacks limbs, having gills for respiration, lay eggs, scales, having fins for locomotion. They are purely aquatic animals found in fresh and marine water on skin. They have jaws and, streamlined body.

2.3 GENERAL CHARACTERISTICS

1. They are aquatic vertebrates, always live in water. They have representation both in fresh water and in marine waters and are also represented in brackish water.
2. Their body is invariably stream lined and they swim with the help of tail.
3. They have paired appendages in the form of fins. Unpaired fins are also present. Fins help in balancing during swimming.
4. They have lateral line system that helps them to know the disturbances in the near by environment.
5. They respire with the help of gills.
6. Have a swim bladder for buoyancy, they show no or little parental care to their young ones
7. Internal skeleton is either cartilaginous or bony.

8. Sexes are separate; fertilization is external or internal.

2.4 CLASSIFICATION UPTO ORDER LEVEL

1. Class- Placodermi

1. Primitive jawed fishes.

2. Full sized functional gill arch preceded by hyoid arch.

Ex. Extinct jawed fishes like*Climatius, Acanthodes etc.*

2. Class- Chondrichthyes (Elasmobranchi)

1. Skeleton of cartilage.

2. Males with claspers.

3. Scales placoid.

(i) Sub-class- Selachii

- Sharks
- Multiple gill slits on either side protected by individual skin flaps.

Order

1 → Squaliformes/ Pleurotremata
- Body typically spindle shaped, 5 to 7 pairs of lateral gill slits.
Ex. Sharks. *Scoliodon, Sphyrna* etc.

2 → Batoidea/ Hypotremata
- Body depressed, Gill slits ventral, five pairs.
Ex. Rays. *Pristis, Rhinobatus*etc.

(ii) Sub-class- Brachyodonti

- Fossil and recent fishes.

Eubrachydonti-- It includes Helodus. Ex. Extinct fishes

Order

→ Holocephali
- Gill slits are covered by fleshy operculum & a single gill opening.
- cloaca and scales are absent. Ex. *Chimaera* etc.

3. Class- Osteichthyes

- Skeleton chiefly of bone.
- Skin with many mucous glands.

(i) Sub-class- Actinopterygii-Ray fined fishes.

(a) Super-order- Chondrostei- Tail fin heterocercal.

1 Order- Polypteriformes- 8 or more dorsal fin. Ex.-*Polypterus.*

2 Order-Acipenseriformes- snout long. Ex. *Acipenser*

(b) Super-order- Holostei- scale ganoid type.

1 Order- Amiiformes- snout normal, Tail fin short. Ex. *Amia*

2 Order- Lepidostiformes- snout& body elongated. Ex. *Lepidosteus*.

(c) Super-order- Teleostei- ganoid scales reduces or absent.

1 Order- Clupeiformes- Tail fins is homocercal. Ex. *Hilsa*

2 Order- Scopeliformes- Dorsal and anal fin without spines. Ex. *Harpodon*

3 Order- Cypriniformes- Air is connected with pharynx by a duct. Ex. *Labeorohita*

4 Order- Ophiocephaliformes- Air bladder long without duct. Ex. *Channa*

5 Order- Anquilliformes- Eel, body elongated and slender like. Ex. *Anguilla*

6 Order- Beliniformes- Fins without spines. Ex.*Exocoetus*

7 Order- Syngnathiformes- Physoclistic, swim bladder closed. Ex. *Hippocampus*

8 Order- Perciformes- Fins usually with spines. Ex. *Anabas*

9 Order- Pleuronectiformes- Body flat, head asymmetrical. Ex. *Synaptura*

10 Order- Tetradontiformes- scales are modified in to spines. Ex. Diodon

11 Order- Echeneiformes- first dorsal fin modified into adhesive disc. Ex. Echeneis

12 Order- Lophiiformes- Dorsal fins like flexible spines. Ex. *Lophius*

(ii) Sub-class- Sarcopterygii- 2 dorsal fins, caudal fin heterocercal with epichordal lobe.

1 Order- Crossopterygii- Lobed finned fishes. Ex.*Latimeria*

2 Order- Dipnoi- Lung fishes. Ex. *Protopterus*

2.5.1 Model on General Anatomy of *Scoliodon*

1. Procedure for dissection:

Take preserved *Scoliodon* and wash it with tap water. Lay down the fish in a dissecting tray ventro-dorsally, i.e ventral surface upwards. Fix the specimen by pins. Pins are to be fixed in pectoral fins. The abdominal cavity is opened by a median ventral incision in the body-wall

extending from the anterior border of the pelvic fins to the anterior border of the pectoral fins. Cut transversely along the line of pectoral and pelvic fins and pin the flaps of the body-wall.

Study the internal viscera and note the following organs:

(1) Digestive Organs: The following digestive organs are seen :

(i) **Stomach: -** 'J' shaped and divided into the proximal cardiac stomach & distal pyloric stomach joined by a blind sac.

(ii) **Intestine: -** Intestine is a wide tube about the diameter of cardiac stomach

(iii) **Rectum: -** Rectum is formed by the narrowing of the intestine. It opens into the cloaca, rectal gland or caecal gland is a small diverticulum from the dorsal wall of the rectum.

(iv) **Liver:** Liver is an elongated gland, lies below the cardiac stomach. It consists of two lobes which extend back along the greater part of the abdominal cavity.

(v) **Gall Bladder:** it is thin –walled sac, found on the dorsal lobe.

(vi) **Pancreas:** Pancreas is a compact bilobed gland situated in the angle between the two limbs of stomach.

(vii) **Spleen:** Spleen is a large brownish red body attached to the loop of the stomach.

(2) Vascular Organs: The following vascular organs are seen:

(i) Pericardial cavity (ii) heart (two chambered) (iii) Conus arteriosus and (iv) ventral aorta

(3)Urinogenital organs: The following reproductive organs are seen:

(i) Female urinogenital organs: It includes ovaries, oviducts with oviducalfunneels, uterus, epigonal organs, shell glands, caecal gland, kidneys, ureters and cloaca.

(ii) Male urinogenital Organs: Male urinogenital organs include testes, vasa efferentia, vas deferentia, vesicular seminalis, sperm sacs, caecal gland, kidneys, ureters and cloaca.

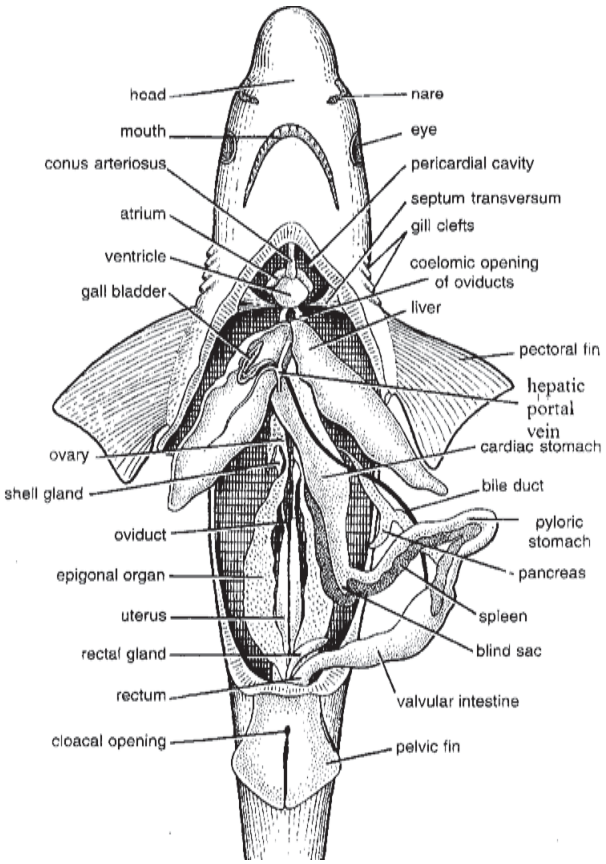

Fig. 2.1 Model on general anatomy of Scoliodon

2.5.2 Heart, Afferent and Efferent Branchial Arteries of Scoliodon

Carefully remove the muscles and expose the pericardium which encloses the heart. Remove the pericardium carefully and thus heart will be exposed.

A. Heart: Heart is dorso-ventrally bent, muscular tube consisting of four chambers, i.e sinus venosus, auricles, ventricle and conus arteriosus.

(a) **Sinus venosus :** It is a triangular thin-walled sac

(b) **Atrium (auricle) :** It is a large triangular sac

(c) **Ventricle:** Ventricle is the most prominent chamber and lies ventral to the atrium or auricle.

(d) **Conus arteriosus**: It is a stout muscular tube extending from the ventricle to the anterior apex of the pericardial cavity.Theconus arteriosus is continued forward through the wall of the pericardium as the ventral aorta.

B. Afferent Branchial Arteries

1. Ventral Aorta: it runs up to the posterior border of the pharynx. Distally it divides into two innominate arteries. It bifurcates into two branches the innominate arteries, each of which again divides into first and second afferent branchial arteries.
2. First afferent branchial artery- supplies to all the gill-lamellae of the hyoideandemibranch.
3. Second afferent branchial artery- supplying branches to both the anterior and posterior gill-lamellae.
4. Third, Fourth and Fifth afferent branchial arteries- runs along the outer borders of the second, third and fourth branchial arches.

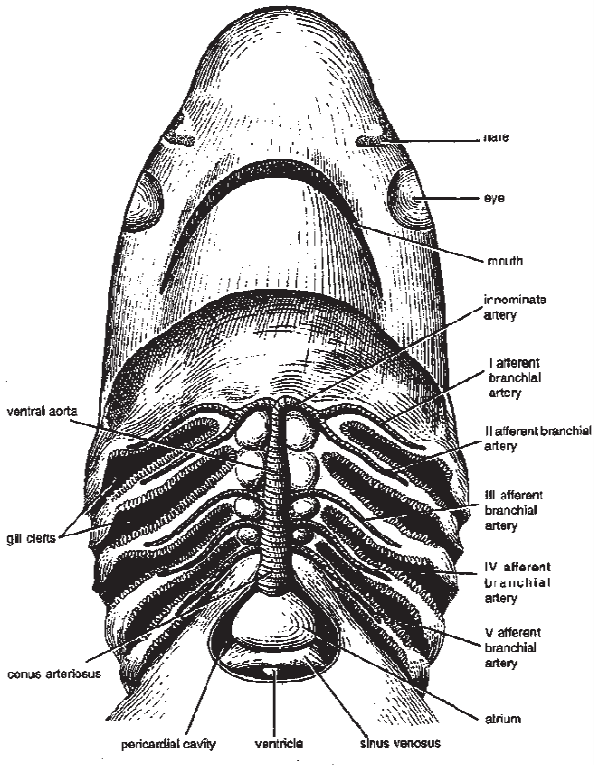

Fig. 2.2 Afferent Branchial Arteries

(C) Efferent Branchial Arteries:

Procedure for dissection: dissect the fish from roof of the pharynx and expose the Efferent Branchial Arteries which are forming loops around each gill-cleft.

1. There are 9 Efferent Branchial Arteries on each side running along the anterior and posterior border of 5 gill-clefts.
2. I + II , III + IV, V+VI and VII + VIII Efferent Branchial Arteries forms four complete loops round the first four gill-clefts.
3. The IX Efferent Branchial Artery joins with the VIII Efferent Branchial Arteries.
4. The four loops are connected with one another by short longitudinal vessels which connects the posterior efferent of a gill-cleft with the anterior efferent of the next gill-cleft behind.
5. Each of the four Efferent Branchial loops is continued into an epibranchial artery.
6. The four pairs of epibranchial arteries unite to form median dorsal sorts.
7. In the anterior region hyoideanepibranchials and branches of dorsal aorta are seen.

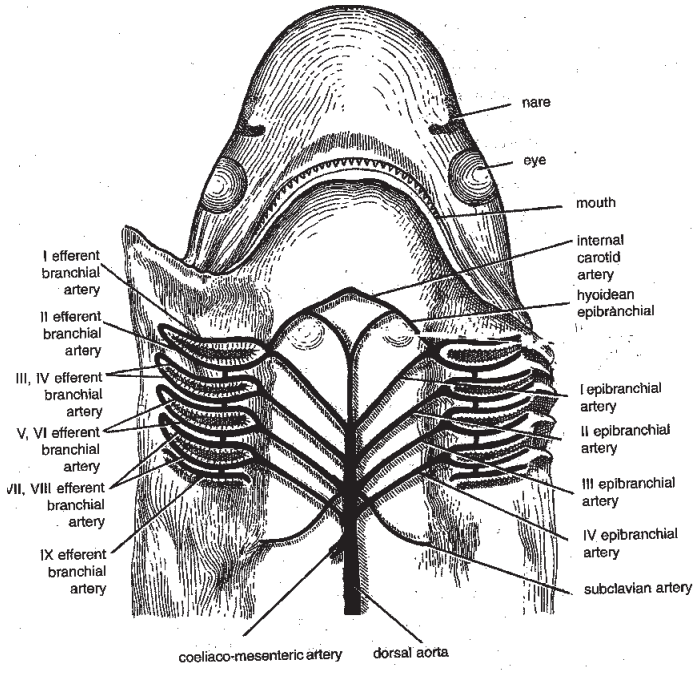

Fig. 2.3 Efferent Branchial Arteries

2.5.3 Cranial Nerves of Scoliodon

Procedure for dissection: Make a longitudinal incision in the integument in the middle of the head from the gill cleft region upto the snout. Carefully remove the flap of integument by giving the transverse incisions at the level of pectoral fins. Remove the cranial roof in order to expose the brain. Expose the cranial nerves on the right side and trace them from their origin to their innervation. There are 10 pairs of cranial nerves.

The following Cranial nerves are exposed.

1. **I or Olfactory nerve** is a sensory in nature, originates from olfactory lobe & innervated in nose epithelium.

2. **II or Optic nerve** is sensory in nature, originates from optic thalamus & innervated in retina.

3. **III or Oculomotor nerveis** motor in nature, originates from ventral surface of mid brain & innervated in eye muscles.

4. **IV or Pathetic nerve or Trochlear nerve** is motor in nature, originates from dorso-lateral side of mid brain & innervated in superior oblique muscle of eye.

5. **V or Trigeminal nerve**is mixed in nature, originates from side of medulla just below corpora restiformis& it **has four branches:**

(i) **Ophthalmicussuperficialis**is innervated in skin of snout.

(ii) **Ophthalmicusprofundus** isinnervated in olfactory capsule and dorsal skin of snout.

(iii) **Maxillaris has two branches**

(a) Maxillaris superior is innervated in skin of upper jaw.

(b) Maxillaris inferior is innervated in posterior part of upper lip.

(iv) **Mandibularis**is innervated in muscles of lower jaw.

6. **VI or Abducens nerve** is motor in nature, originates from ventral side of medulla & is innervated in posterior and external rectus muscles of eyes.

7. **VII or Facial nerve** is mixed in nature, originates from the side of medulla & it **has 4 branches**

(i) **Ophthalmicussuperficialis**is innervated in sense organs of snout.

(ii) **Ramus palatinus**is innervated in roof of pharyngeal and buccal cavity.

(iii) **Ramus buccalis**is innervated in infra-orbital lateral line organ.

(iv) **Ramus hyomandibularis has three branches:-**

(a) Mandibularis externus isinnervated in mandibular canal.

(b) Mandibularis internusisinnervated in mucous membrane of buccal floor.

(c) Hyoideanisinnervated muscles of hyoid arch.

8. **VIII or Auditory nerve** is sensory in nature, originated from side of medulla close to V and VIII cranial nerves & innervated in internal ear.
9. **IX or Glossopharyngeal nerve** is originated from ventro-lateral side of medulla & it **has two branches**

(i) Pre-trematic is sensory in nature & innervated in mucous membrane 1 st gill slit & pharynx.

(ii) Post-trematic is mixed in nature & innervated in muscles of pharynx.

10. **X or Vagus nerve** is mixed in nature, originated from side of medulla and it has 3 branches

(i) **Branchialisnerve** is innervated in gills

(ii) **Viceralis nerve** is innervated in visceral organs

(iii) **Lateralis nerve** is innervated in lateral line of trunk

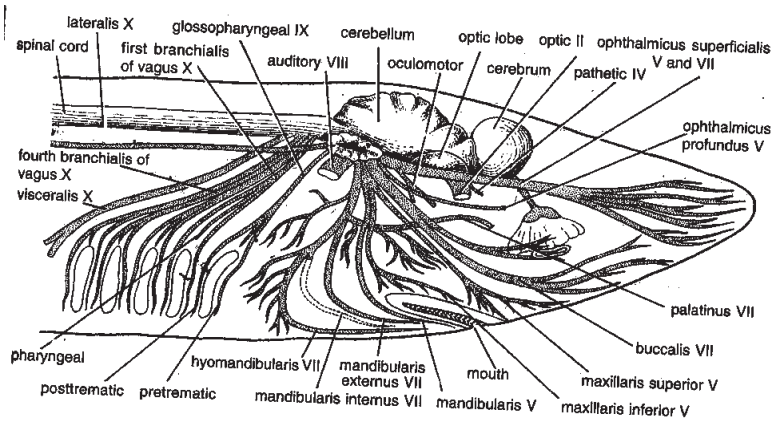

Fig.2.4 Cranial Nerves of Scoliodon

2.5.4 Internal Ear of *Scoliodon*

Procedure for dissection: Take preserved *Scoliodon* and wash it with tap water. Remove the skin of the portion between the eye and first gill-cleft upto the mid-dorsal line. Remove the muscles completely so as to expose the cartilage of auditory capsulethat lodges the internal ear. The auditory capsule shows three ridges of semi circular canals. Carefully remove the cartilage of the ridges with the help of forceps or needle without injurying or breaking the canals. After locating the canals remove the cartilage present between the canals so as to expose the other parts of the ear.

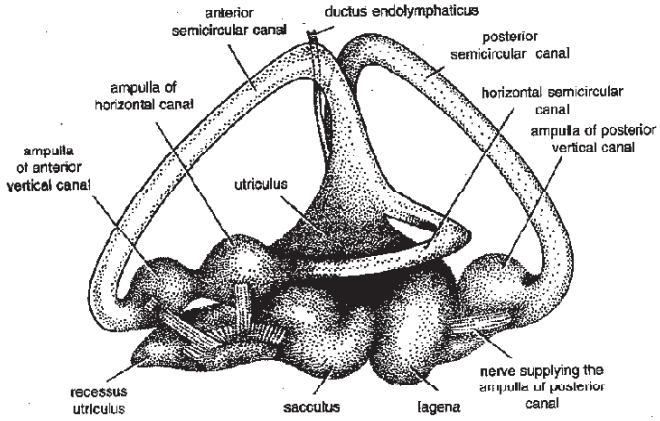

Fig.2.5 Internal Ear of Scoliodon

2.6 STUDY OF PERMANENT SLIDES OF SHARK T. S. PASSING THROUGH DIFFERENT BODY REGIONS

2.6.1. V.S of skin of shark

1. Shark skin comprises of two layers i.e., epidermis and dermis.
2. Epidermis is made up of stratified squamous epithelium which contains a few mucous secreting cells.
3. The dermis is made up of connective tissue and melanophores which lie close to epidermis.
4. Section of placoid scale is seen.

5. A placoid scale in section consists of a central pulp cavity surrounded by a thick layer of dentine and that is also covered by a surface layer of enamel.
6. The enamel is the hardest part of animal tissue.
7. The pulp cavity contains blood vessels, nerves and odontoblast cells.

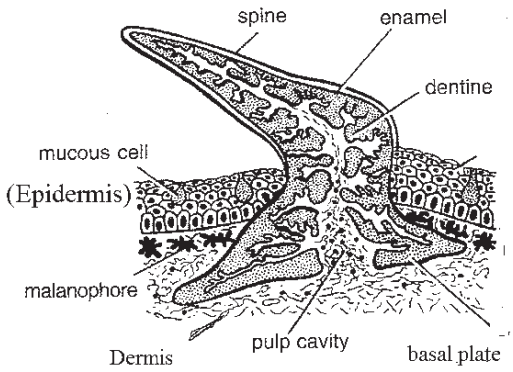

Fig. 2.7 V.S of skin of shark

2.6.2 T.S of *Scoliodon* through Branchial Region

1. The outer surface is covered by integument comprising of epidermis, dermis and dermal placoid scales.
2. dorsal half portion has thick segmental muscles bundles or myotomes, separated by myocommata are seen in the section.
3. Myotomes have concentrically arranged muscle fibres of striated type and myocommata composed of tough connective tissue.
4. Middle of the myotomes cartilaginous vertebra having the spinal cord.
5. Below vertebra lies the dorsal aorta and notochord is found just below the spinal chord.
6. Oesophagus is found just below the dorsal aorta, below the oesophagus lies thin walled pericardial cavity containing the heart.
7. Coracoid cartilages give support to the pericardium.

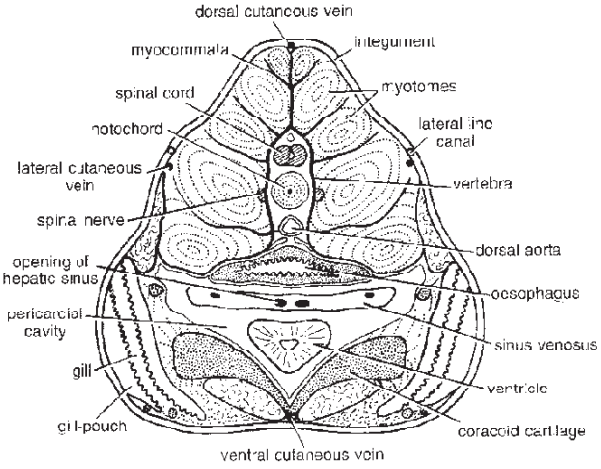

Fig. 2.8 T.S of Scoliodon through Branchial Region

2.6.3. T.S of *Scoliodon* through Base of Pelvic Fin of Male and Female

1. It shows body wall layers, nerve cord, notochord, kidney, uterus in females and seminal vesicles in males, etc.
2. The outer surface is covered by integument comprising of epidermis, dermis and dermal placoid scales.
3. Myotomes contains concentrically arranged muscle fibres and are separated by the myocommata.
4. Vertebra lies in the central axis. Dorsal aorta lies below the vertebra.
5. Kidney and ureters lie below the dorsal aorta.
6. In male two seminal vesicles lie below the ureters and in female two uteri fused together to form single uterus, which lies the ureters.

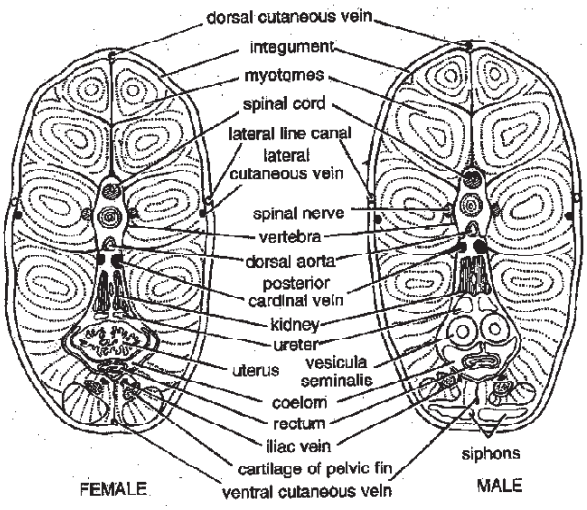

Fig.2.9 T.S of Scoliodon through Base of Pelvic Fin of Male and Female

2.6.4. T.S of *Scoliodon* through Caudal Region

1. The body wall is composed of integument (comprising of epidermis, dermis and dermal placoid scales) and muscle layer.

2. Myotomes formed of concentrically arranged striated muscle fibres and are separted by themyocommata.

3. Vertebra is found in sub-equatorial mechanical axis. Spinal cord and notochord are enclosed in the vertebra.

4. Caudal vein is found below the caudal artery and later is found below the vertebra.

5. No body organs are present in caudal region.

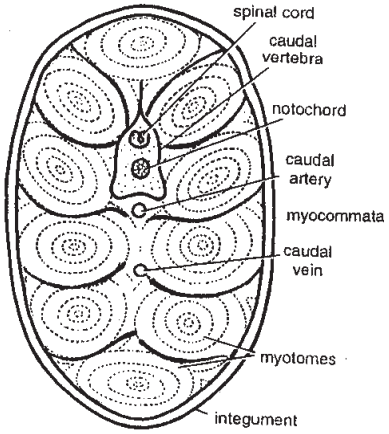

Fig. 2.10 T.S of Scoliodon through Caudal Region

2.6.5. Ampulla of Lorenzini

1. The ampullae of Lorenzini are thermoreceptors.

2. Each ampulla is composed of ampullary sac and an elongated tubule.

3. Each ampullary sac consists of 8 to 9 radially dilated chambers arranged around a central core, the centrum.

4. Long tubule is opens at the surface of head through a external aperture, ampullary sac is filled up with mucus.

5. Each ampulla is innervated by the nerve branches of VIIth cranial nerve.

6. In the snout of scoliodon the ampullae lie together in clusters like bunches of grape.

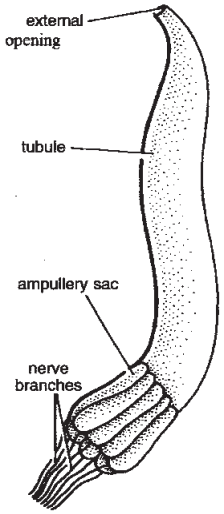

Fig. 2.11 Ampulla of Lorenzini

2.6.6 Different kinds of scales of fish

1. Placoid scale of *Scoliodon* (Whole mount)

1. The placoid scales are arranged in regular oblique rows; they are dermal in origin & covering the entire surface of the body and form the exoskeleton of the shark.
2. Placoid scales are small pointed and tri-radiate denticles (trident spines) found embedded in the dermis.
3. A typical placoid consists of a diamond shaped or rhomboidal basal plate having an opening of the pulp cavity and flat trident spine.
4. The basal plate is formed of a trabecular calcified tissue, the cement.
5. The spine is composed of hard calcareous substance, the dentine which is covered by a hard material, vitrodentine.
6. Placoid scale contains a pulp cavity in spine.
7. The pulp cavity contains odontoblasts dentine forming cells, blood vessels, nerve and lymph chambers.
8. Placoid scales are found in dermis of elasmobranch fishes.

Identifying characteristics: Scale has trident spines.

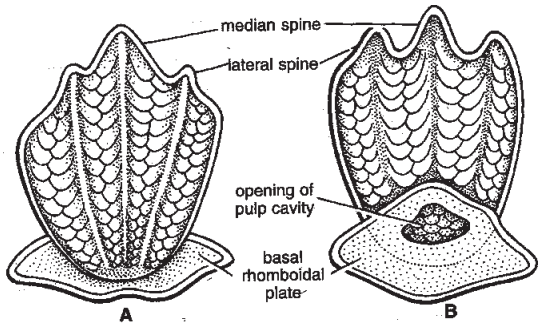

Fig. 2.12 Placoid scale of Scoliodon (Whole mount)

2. Cycloid scale

1. Cycloid scales are found in teleosts (Carps) and dipnoi (Lung fishes).
2. These are soft and dermal plates.
3. They are located in dermal pockets and possess concentric lines of growth.
4. Each cycloid scale is roughly circular.
5. Each scale is composed of a central nucleus and numerous lines of growth.
6. The posterior part of the scale is having numerous longitudinal grooves for sucking the nourishment from the skin.
7. Pulp cavity and dentine are entirely absent.
8. Cycloid scales are derivatives of the ganoid scales in which ganoin and cosmine layers and bone cells are lost.

Identifying characteristics: scale contains concentric lines of growth.

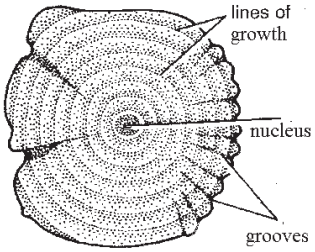

Fig. 2.13 Cycloid scale (Whole Mount)

3. Ctenoid scale (whole mount)

1. Ctenoid scales are commonly found in teleosts and actinopterygian fishes.
2. These are soft and dermal translucent plates.
3. Each ctenoid scale is flat and somewhat oval in shape.
4. Each scale is composed of a central nucleus and numerous lines of growth.
5. The anterior free border bears numerous small teeth like structure.
6. The posterior border remains embedded in the skin and slightly wavy.
7. Numerous longitudinal grooves are present on the posterior border and as such these grooves are used for sucking the nourishment from the skin.
8. Pulp cavity and dentine are entirely absent.
9. Ctenoid scales are derivatives of ganoid scales in which ganion, cosmine layers and bone cells are lost.

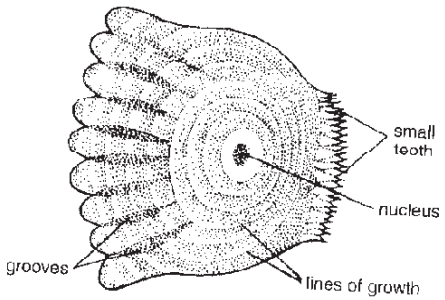

Fig. 2.14 Ctenoid scale (Whole mount)

4. Ganoid scale (Whole mount)

1. Ganoid scales were the characteristic of primitive actinopterygii.
2. These are purely dermal in origin.
3. Each scale has bony base, covered by shining material called ganoin.
4. These scales fit together like tiles and arranged in diagonal rows.

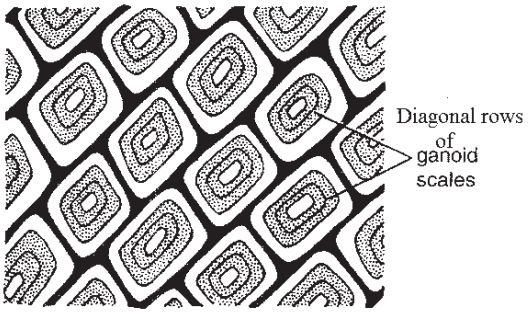

Fig. 2.15 Ganoid scale (Whole mount)

5. Rhomboid Scale (Whole mount)

1. Rhomboid scales are characteristic feature of Lepidosteus (Gar-pike).
2. Each scale is more or less rectangular in shape.
3. Each scale possess lines of growth and a nucleus.

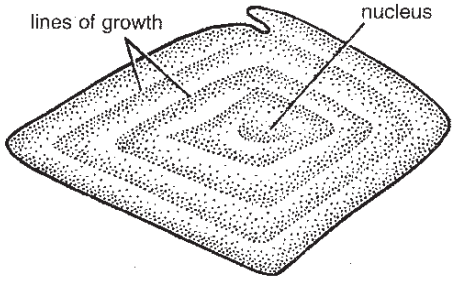

Fig. 2.16 Rhomboid Scale (Whole mount)

2.7 STUDY OF MUSEUM SPECIMENS

1 *Sphyrna* (Hammer- Headed Shark):

General characters:-

1. Body is elongated, measuring 4-5 meters in length and is divided into head, trunk and tail.

2. The head is flattened in front and expanded sideways into two conspicuous lateral lobes, resembling a hammer.
3. The eye lies at the tips of lateral lobs.
4. Mouth is crescentic and ventral in position.
5. Nostrils lie ventrally at the base of lateral lobes.
6. Five pairs of lateral gill slits are present.
7. Two dorsal fins are present. The first dorsal fin is situated in front the pelvic fin and second dorsal fin oppositeto the anal fin.
8. Spiracles are absent.
9. Vertebrae are asterospondylus.
10. Viviparous and produces about 40 young ones
11. Ferocious and attack its prey with its head.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Order : Chondrichthyes--- endoskeleton cartilaginous, operculum absent (Elasmobranchi)

Sub-class : Selachii--- shark and rays, gills in separate clefts

Order : Squaliformesor --- gill slits lateral, pectoral fins small Pleurotremata

Genus : *Sphyrna*

Species : *zygaena*

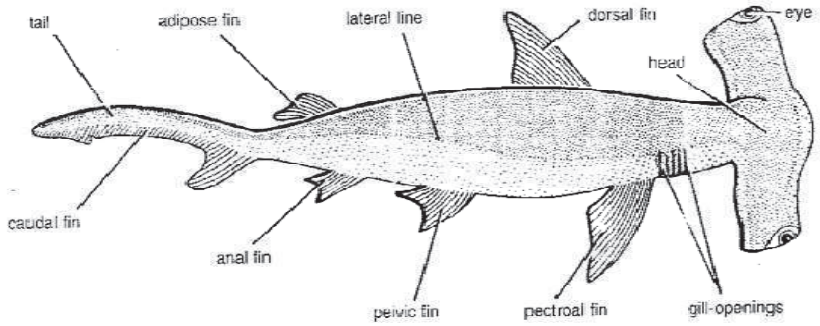

Fig. 2.17 Sphyrna (Hammer- Headed Shark)

2 *Pristis* (Saw-fish):

General characters:-

1. Body is elongated (length is about 3-6 metres), depressed and shark like
2. Head and skull prolonged into a long flattened rostrum, lateral margins are provided with a series of strong tooth like denticles giving its appearance of saw.
3. No rostral tentacles.
4. Teeth in jaws are minute and obtuse.
5. Spiracles are present behind the eyes.
6. Dorsal fins are large the first dorsal fin is opposite to the pelvic fin.
7. Tail is well developed and terminating in heterocercal caudal fin.
8. The fish is used for liver oil of high vitamin value and skin for scale boards.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Order : Chondrichthyes--- endoskeleton cartilaginous, operculum absent (Elasmobranchi)

Sub-class : Selachii--- shark and rays, gills in separate clefts

Order : Hypotremata --- Gil slits ventral, spiracle present

Genus : *Pristis*

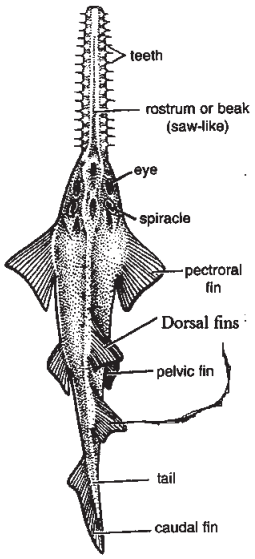

Fig. 2.18 Pristis (Saw-fish)

3 *Torpedo* (Electric ray):

General characters:-

1. Body is dorso-ventrally flattened and disc shaped which is sub circular.
2. The semicircular anterior margin of the disc is supported in the centre by a branched prenasal rostrum and laterally by the branched preorbital cartilages.
3. Skin is smooth without scales.
4. Mouth is transverse and ventral.
5. Quadrangular naso –frontal lobe is present.
6. Spiracles are present behind the eyes.
7. Gill-slits are ventral.
8. A pair of large electric organs, one on either side in between the pectoral fins and the head.
9. An electric organ consists of muscle fibres arranged in blocks and serves as a batteries.
10. Tail is relatively short with two dorsal fins and a caudal fin.
11. Viviparous

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are

present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Order : Chondrichthyes--- endoskeleton cartilaginous, operculum absent (Elasmobranchi)

Sub-class : Selachii--- shark and rays, gills in separate clefts

Order : Hypotremata--- Gil slits ventral, spiracle present

Genus : *Torpedo* (Electric ray)

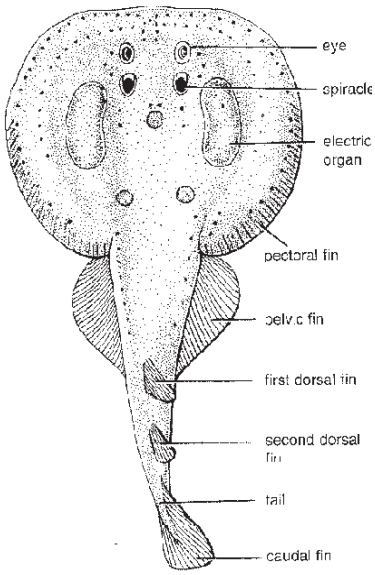

Fig.2.19 Torpedo (Electric ray)

4 *Trygon* (Sting ray):

General characters:-

1. *Trygon* is commonly known as sting –ray because presence of 3 stings or spines in the tail.
2. Body is flat. Disc is sub –rhomboidal or broader than long.
3. Pectoral fins are confluent with the sides of the head.

4. Mouth is ventral in position.
5. A rectangular naso-frontal flap is present in front the mouth.
6. Spiracles are present behind the eyes on the dorsal side.
7. Five pairs of gill slits are present on the ventral side.
8. Tail is long, slender and whip like terminating in a small caudal fin and armed with a sharped serrated poisonous string.
9. Claspers are present near the pelvic fin in the male.
10. Viviparous

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Order : Chondrichthyes--- endoskeleton cartilaginous, operculum absent (Elasmobranchi)

Sub-class : Selachii--- shark and rays, gills in separate clefts

Order : Hypotremata --- Gil slits ventral, spiracle present

Genus : *Trygon*

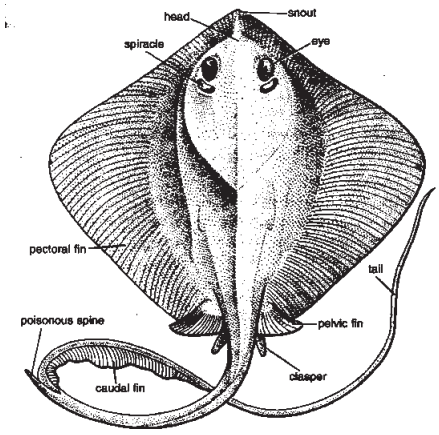

Fig. 2.20 Trygon (Sting- ray)

5 *Acipenser* (Sturgeon):

General characters:-

1. Body is elongated (about 2-4 metres in length) and covered with five rows of bony scutes, one dorsal, two laterals and two ventrals.
2. Rostrum is well developed and often massive, with a transverse row of four preoralbarbles.
3. Mouth is small, ventral and protrusible. Jaws without teeth.
4. Presence of functional spiracles.
5. Operculum is represented by an opercular bone.
6. The air bladder is smooth, oval and non sacculated having a lining of ciliated epithelium.
7. Caudal fin bilobed (heterocercal). Paired fins are also present.
8. 2-3 million eggs are laid by a single fish.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Super-Order :Chondrostei --- body covered with bony scutes or naked, tail heterocercal.

Order : Acipenseriformes--- snout elongated, notochord unsegmented

Genus : Acipenser

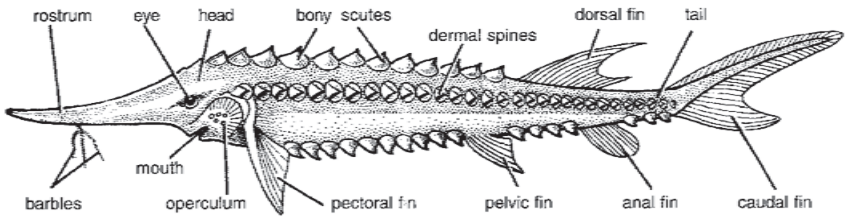

Fig. 2.21 Acipenser (Sturgeon)

6 *Polypterus* (Bichir):

General characters:

1. It is one of the most primitive living bony fish and could be easily regarded as living fossil.
2. Body is elongated and covered with rhombic ganoid scales.
3. Grows to a length of 1 meters.
4. Surface covering consist of a thin shiny enamel called ganoin.
5. Head is covered with a horny shield, bearing the tubular nostrils and eyes.
6. Dorsal fin consists of number of finlets each with a spine.
7. Pectoral fins have a scale covered fleshy lobe at the base.
8. Pelvic and anal fins are small.
9. Caudal fin is symmetrical externally.
10. Spiracles are present and there are 4 gill arches.
11. Air bladder is bilobed and cellular serving for respiration.
12. Development is indirect.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Super-Order :Chondrostei --- body covered with bony scutes or naked, tail heterocercal.

Order : Polypteriformes --- rhombic ganoid scales are present, dorsal fin with finlets.

Genus : *Polypterus* (Bichir)

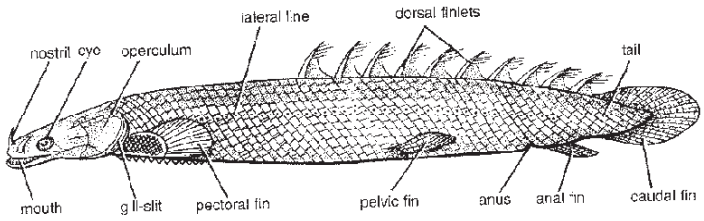

Fig. 2.22 Polypterus (Bichir)

7. *Hippocampus* (Sea-horse):

General characters:-

1. Body is more or less elongated (size is about 5-17 cm) having an exoskeleton of ring-like bony plates..
2. Mouth is at the extremity of an elongated tubular snout.
3. Trunk is compressed. Somewhat elevated with 10 – 12 rings.
4. Pectoral and dorsal fins are small.
5. Pelvic and caudal fins are absent.
6. Tail is prehensile and used for coiling the sea weeds.
7. Operculum is fused with the body wall ventrally and posteriorly, leaving a small upwardly directed branchial aperature.
8. Females have a small anal fin.
9. Male possesses a brood pouch on the abdomen. In these pouch eggs are retained until they hatched as young ones showing parental care.
10. They swim in a vertical position by undulation of dorsal fin.
11. It exhibits mimicry by having numerous prominent spines.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder

Order : Syngnathiformes --- body covered with protective layer of scales or bony rings, Snout tubiform

Genus : *Hippocampus*

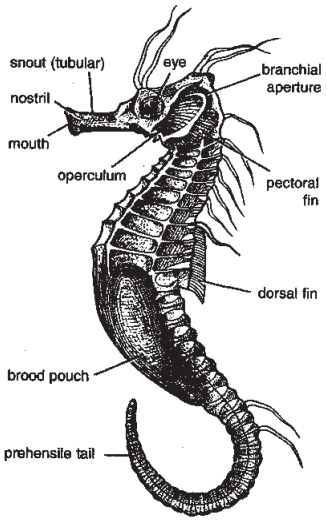

Fig. 2.23 Hippocampus (Sea-horse) - Male

8. *Exocoetus* (Flying fish):

General characters:-

1. Body is moderately elongated, compressed and covered with cycloid scales.
2. Color is bluish and silver, Pectoral fins have black spots.
3. Mouth opening is small but both the jaws bear teeth.
4. Pectoral fins are enormously elongated to form wing like structures. They serve as parachute to sustain the fish in its gliding leaps.
5. Dorsal and anal fins are short.
6. Tail is hypobatic.
7. Air bladder is present.
8. Oviparous.
9. It is consider as a good edible fish.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder

Order : Beloniformes--- fins without spines, jumping into air and glide with pectoral fins

Genus : *Exocoetus*

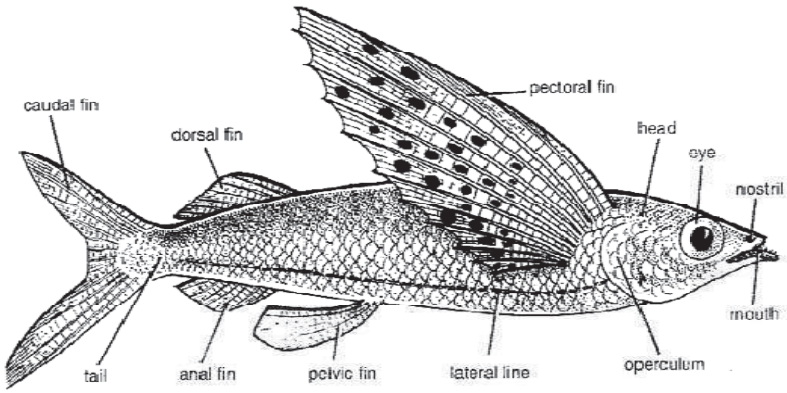

Fig. 2.24 Exocoetus (Flying Fish)

9. *Anguilla*

General characters:-

1. Body is elongated, cylindrical and snake like. It extends upto 1 metres.
2. Body is covered by minute scales embedded in the skin and arranged obliquely at right angles to one anotherforming a curious pattern.
3. Color is brown on the back and yellowish below.
4. Dorsal, anal and caudal fins are long and narrow & joined together forming a continuous fin, fins are supported by fin rays.

5. Pectoral fin small and pelvic fin is absent.
6. Tail is long and caudal fin is quite large.
7. Fins are supported by rays, spines being absent.
8. Gill opening is narrow and minutes.
9. On each side operculum covers the gill sli

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder

Order : Anguilliformes --- body elongated eel-like, skin naked or with minute scales, dorsal, caudal & anal fins are long narrow

Genus : *Anguilla* (eel)

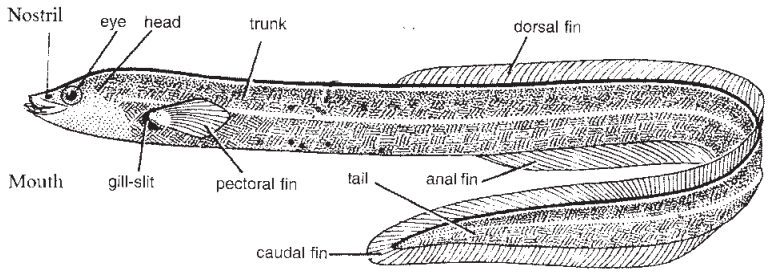

Fig. 2.25 Anguilla

10.*Echeneis* (Sucker fish):

General characters:-

1. Body is elongated (length is about 1 metre), fusiform and covered with small cycloid scales.
2. Head is depressed and furnished with an adhesive organ.
3. Eye is lateral in position.
4. Mouth cleft is wide and deep.
5. First dorsal fin is modified into an adhesive disc.
6. Second dorsal and anal fins are elongated without spines and opposed to each other.
7. Adhesive disc is flat, oval and transversely furrowed and is used for attachment.
8. Air Bladder is absent.
9. Tail is homocercal & caudal fin bilobed.
10. It is employed for catching the turtles on the east coastal region of Africa.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Pisces --- paired fins, gills and skin with scales
Class : Osteichthyes --- bony fishes
Sub class : Actinopterygii --- ancient fishes
Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder
Order : Echeneiformes --- first dorsal fin is modified into an adhesive-disc, air bladder is absent
Genus : Echeneis

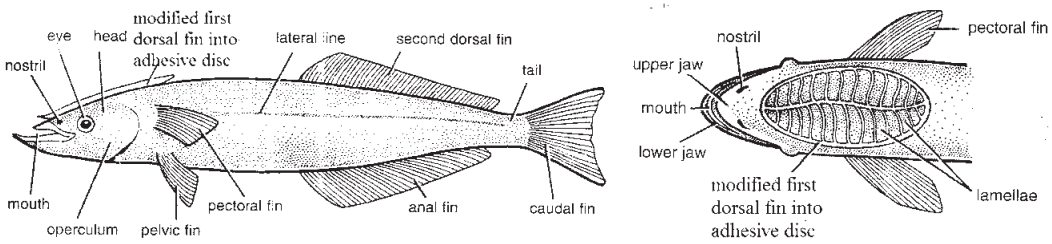

Fig. 2.26 Echeneis (Sucker fish)

11 *Diodon* (porcupine fish):

General characters:-

1. Body is globular.
2. Skin is covered with stiff and movable dermal spines, which serve as organs of defence.
3. Mouth opening is small and jaws without median suture.
4. Inter-operculum is rod like and attached to the anterior limb of sub-operculum.
5. Paired pectoral fin near operculum. Dorsal fin near caudal fin. Caudal fin is rounded and tilted upwards anal fin opposite to dorsal fin.
6. Gills are three in number. Gill- slits is situated near the pectoral fin.
7. Air bladder is present.
8. The flesh of this fish is regarded as poisonous.
9. A thin walled inflatable gastric diverticulum is present which allows the whole body to be puffed (leathery) into a globular shape and the spines become defensively erected.
10. This fish is poisonous and non-edible.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Pisces --- paired fins, gills and skin with scales

Class : Osteichthyes --- bony fishes

Sub class : Actinopterygii --- ancient fishes

Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder

Order : Tetrodontiformes--- scales are modified into spines body covered with scutes or bony plates

Genus : *Diodon*

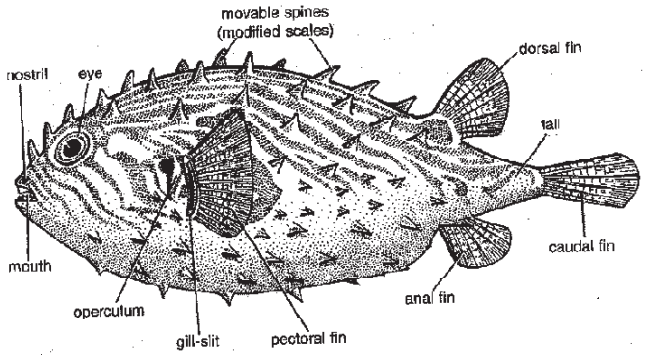

Fig. 2.27 Diodon (porcupine fish)

12 *Protopterus* (African lung fish):

General characters:-

1. *Protopterus* is commonly known as Nile lung fish.
2. Body is elongated (about 2 metres long), cylindrical and more or less eel like.
3. Small cycloid scales are completely enclosed in the skin.
4. The paired fins are long, thin and filamentous.
5. Dorsal, caudal and anal fins continuous.
6. Pectoral and pelvic fins are reduced to slender appendages and without fin rays.
7. Tail is used for locomotion.
8. There are six branchial arches and five gill slits.
9. Larval gills are usually retained as vestigial organs throughout life.
10. Air bladder is double lung.
11. It breathes through lungs as well as gills.
12. It s undergoes summer sleep when condition are not favourabele

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Pisces --- paired fins, gills and skin with scales
Class : Osteichthyes --- bony fishes
Sub-class : Choanichthyes/ Sarcopterygii --- nostrils connected to mouth cavity, paired fins with larger median lobe.
Order : Dipnoi --- Lung fish, premaxilla or maxilla absent, air bladder lung like, tail diphycercal
Genus : *Protopterus* (African lung fish)

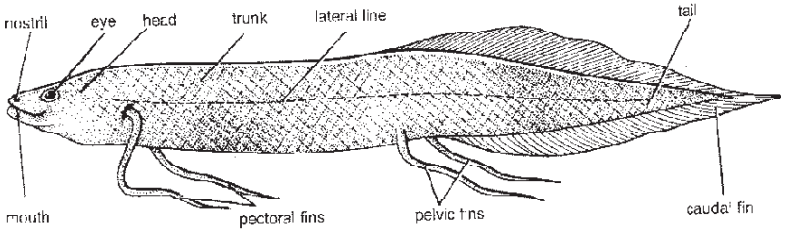

Fig. 2.28 Protopterus (African lung fish)

13 *Synaptura or Pleuronectes* (Flat fish)

General characters:-

1. Body is thin, laterally compressed and flat.
2. Body scales are imbricate, cycloid or ctenoid.
3. Side of the body bearing the eyes turned upwards being coloured, while lower side is white.
4. ead is asymmetrical. Both eyes are situated on the upper side.
5. Mouth is narrow and more or less protractile.

6. Right side is white, left side is pigmented while lower side is silvery white.
7. Dorsal and anal fins are long without spines and confluent with the caudal fin.
8. Caudal fin is well developed.
9. Air bladder is absent.
10. Gills four, a slit behind the fourth, pseudobranchiae are present.
11. Adapted for bottom living.
12. It is used as edible fish.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Pisces --- paired fins, gills and skin with scales
Class : Osteichthyes --- bony fishes
Sub class : Actinopterygii --- ancient fishes
Superorder : Teleostei--- moderately finned fishes, hydrostatic swim-bladder
Order : Pleuronectiformes--- flat fish, fins usually without spines, air bladder is absent in adult
Genus : *Synaptura*(Flat fish)

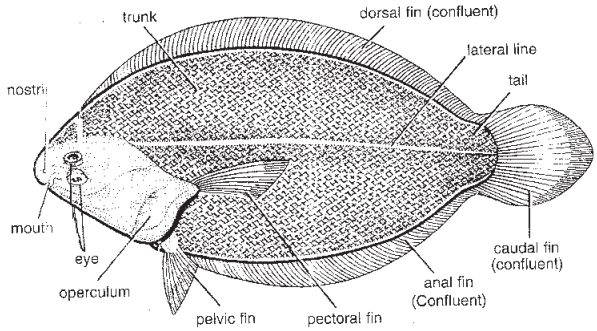

Fig. 2.29 Synaptura or Pleuronectes (Flat fish)

14 *Chimaera*(Rat fish or King of Herrings) :

General characters:-

1. Body is elongated (measuring upto 1 meter in length and shark like with compressed head and blunt snout.
2. Skin is naked with a characteristics open groove lodging the lateral line system.
3. Mouth and nostrils are ventral in position.
4. Pectoral and pelvic fins are enlarging.
5. Two dorsal fins, the first dorsal fin bears an immensely bony anterior erectile dermal spine while the second dorsal fin isnon-erectile over the pectoral fins with a stout spine in front and posterior one is continuous.
6. Caudal fin is of diphycercal type.
7. In male fish a pair of claspers is present behind the pelvic fins.

Systematic position:-

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Pisces --- paired fins, gills and skin with scales
Class : Chondrichthyes--- endoskeleton cartilaginous, operculum absent (Elasmobranchi)
Sub-class : Brachyodontii --- crushing type dentition
Order : Holocephali --- spiracle absent, operculum absent
Genus : *Chimaera*
Species : *monstrosa*

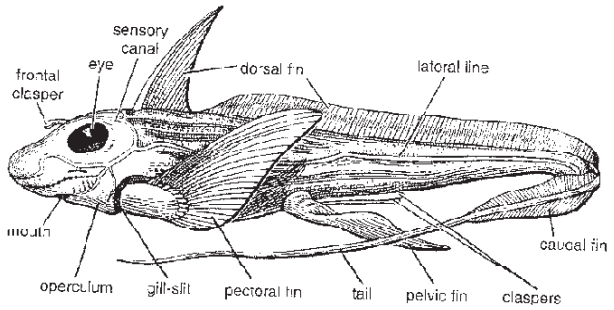

Fig. 2.30 Chimaera (Rat fish or King of Herrings)

2.8 SUMMARY

Super class Pisces (L., piscis, fish) includes fish or fish like aquatic form with gills, paired fins and scaly skin. These are cold blodded, inhabiting all aquatic ecosystems from glaciers to oceans. It is a very successful, diverse and widespread group, with about 30.000 species.

Pisces can be segregated into three classes: Placodermi, Chondrichthyes, and Osteichthyes. These classes are distinguished by endoskeleton.

Class Placodermi includes exitinct primitive jawed fish. Their head and thorax was covered with armoured plates, rest of body was scaled. Members of class. Chondrichthyes have cartilaginous endoskeleton. Male have claspers. They are also known as cartilaginous fish.

Members of class. Osteichthyes are better known as "bony fish;" they have bony endoskeleton. Males without claspers.

Fishes are of great economic importance. They are rich source of protein in human diet. Fishes are used as human food, cattle, food and fish oil as medicine for disease control. Their skin as leathers are used in making of shoes and bags. Glue and inglass are also extracted from various organs of fish. Further used in jewelry,scientific study,sports (Angling) and recreation. All cartilaginous fishes feeds on animals and their larva which are of great economic importance to human kind. Several fish are poisonous resulting in painful wounds, fatal sometimes.

2.9 GLOSSARY

Adipose fin – On some species, the fatty fin located between the dorsal and tail fin.

Agnatha (means jawless): The Class Agnatha represents the most primitive 'jawless' vertebrates.

Air bladder – A gas-filled sac in the upper part of the body cavity of many bony fishes. It is located just beneath the vertebral column; its principal function is to offset the weight of the heavier tissue such as bone.

Algae – Simple green plant organism (typically a single cell) commonly found in water.

Anal fin – The unpaired fin that lies along the midline of the body beneath the anus, usually on the back half of the fish.

Backwater – Shallow area of a river that is sometimes isolated, often being located behind a sand bar or other obstruction in the river.

Bony fish - They belong to class Osteichthyes. The vertebrate Class evolved after jawless and cartilaginous fishes. They have jaws, their skeleton is made up of bone and their body is covered with overlapping scales.

Cartilaginous fish- They belong to class Chondrichthyes. Their skeleton is composed of entirely cartilage. The Class includes the sharks, rays and skates (subclass Elasmobranchii) and the ratfish (subclass Holocephali).

Gill Opening – an opening behind the head that connects the gill chamber to the exterior.

Habitat – The natural environment where people, animals and plants live. In an aquatic environment, it includes the water, topography, structure and cover present in a lake.

Ichthyology – The study of fish.

Nares – The nostrils of fish.

2.10 SELF ASSESSMENT QUESTION

1. Which one of the following is applicable to fishes?
   (a) Jawed vertebrates (b) Ectothermic (c) Paired fins (d) All
2. Which one of them is true fish
   (a) Silier Fish (b) Cray Fish (c) Flying Fish (d) Devil Fish
3. *Dipnoans* are
   (a) Marine lobed finned fish (b) Freshwater lobed finned fish (c) Freshwater cartilaginous lobed finned fish (d) Freshwater primitive fish
4. Which one of the following is absent in a cartilaginous fish
   (a) Operculum (b) Pelvic fin (c)Pectoral fin (d) Placoid scale
5. *Sphyrna*is found in
   (a) Sea water (b) Freshwater (c) Deltas (d) deep sea water
6. Fishes are cold blooded except
   (a) *Tuna* (b) SwordFish (c)*Diodon* (d)*Trygon*
7. Heart of fish is
   (a) Four Chambered (b) Three Chambered (c) Two Chambered (d) One Chambered.
8. The common name of Electric Fish is
   (a)*Sphyrna* (b) *Pristis* (c) *Torpedo* (d) *Trygon*

Answer

1(d) 2(c) 3(b) 4(a) 5(d) 6(b)7(c) 8(c)

2.11 REFERENCES

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2.12 SUGGESTED READING

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2.13 TERMINAL QUESTION

Q1 what role scales play to fish?

Scales provides protection against alkalinity of water.

Q2 Why Fish moves from one area to another

Fish move from one area to another because of change of factors like water temperature, water velocity, clarity as well as alkalinity of water.

Q3 Why most fish swim by pushing their body against water sideways.

Body muscles of most fish are built in a way that limits them to lateral movements.

Q5. Why scales are used to find the age of fish.

Scale is permanent structure

Q6 Why cartilaginous fishes are heavier than seawater?

This is so because cartilaginous fish lack swim bladder and lung

UNIT 3: CLASS- AMPHIBIA

CONTENTS

3.1 OBJECTIVES

By the end of this chapter, you will know:

1. General characteristics of Amphibian.
2. Classification up to order level
3. Histological slides of Amphibia.
4. Skeleton of mammals by taking frog as example.
5. Museum specimen of Amphibian.

3.2 INTRODUCTION

Amphibians are vertebrates within class Amphibia. The word amphibia has (come from the Greek-amphibios meaning "dual life" in reference to live in both land and water .They are cold blooded, tetrapods, Some having gills, lay eggs, and lack scales. Majority of species undergoes metamorphosis. All species depend upon fresh water for their survival, and reproduction. There concentration is an indicator of health of ecosystem. Amphibians are not found in marine ecosystem.

3.3 GENERAL CHARACTERISTICS

1. Amphibians live well both on land and in water i.e. amphibious.
2. Amphibians are cold-blooded or exothermic poikilothermous animals. unlike warm-blooded animals, which regulate their body temperature internally, amphibians derive heat from outside their body.
3. The skin is smooth, thin, hairless, porous and rarely scaled. The skin contains both mucus glands and poison glands.
4. Limbs are tetrapod of pentadactyle type, some are limbless.
5. The mouth is usually large with small teeth in upper or both jaws; two nostrils open into the anterior part of the oral cavity.

6. Respiration is accomplished either separately or in combination by lungs, skin, and gills; some larval types possess external gills and these may persist throughout life.
7. A three-chambered heart consisting of two atria and one ventricle.
8. Ten pairs of cranial nerve are present.
9. Amphibians are the only vertebrates to undergo complete metamorphosis.
10. Eggs are usually laid in water or in a moist environment and fertilized externally. They change from an aquatic larval stage to a terrestrial form on reaching adulthood.
11. Larvae tadpoles develop in water/ very moist environments and undergo complete metamorphosis.

3.4 CLASSIFICATION UP TO ORDER LEVEL

Sub class A. Stegocephalia

1. Pentadactyle limbs. Extinct.
2. Skin with scales and bony plates.

Order 1: Labyrinthodontia

1. Primitive tetrapods.
2. Teeth large and folded.

   Example: ***Eryops*** (Extinct)

Order 2: Phyllospondyli

1. Small, like salamander.
2. Weak, poorly ossified limbs,
3. Notochord and nerve cord are enclosed in a common cavity.

   Example: ***Branchiosauras***(Extinct)

Order 3: Lepospondyli

1. Small eel like.
2. Vertebrae of a single piece.

   Example :*Diplocaulus*(Extinct)

Sub class B: Lissamphibia

1. Modern Amphibia.
2. Teeth small and Exoskeleton absent.
3. Respiratory organs are lungs, skin and gills.

Order1 :Gymnophiona or Apoda

1. Limbless.
2. Skull compact, girdle absent.
3. Numerous transverse grooves of wrinkles present on skin.

   Example: ***Ichthyophis***

Order 2: Urodela or Caudata

1. Tailed Amphibian.
2. Paired limbs present.
3. Skin devoid of scales.

   Example :*Salamander*

Order 3 :Anura or Salientia

1. No tail.
2. Body short and broad.
3. Forelimbs are short, while hindlimbs are long.

   Example: Frogs and Toads

3.5 MODEL ON CRANIAL NERVES, HYOID APPARATUS, BRAIN AND COLUMELLA OF FROG

3.5.1 MODEL ON CRANIAL NERVES

Procedure for dissection: take a preserved frog and expose the brain removing the roof of the skull with the help of scalpel.

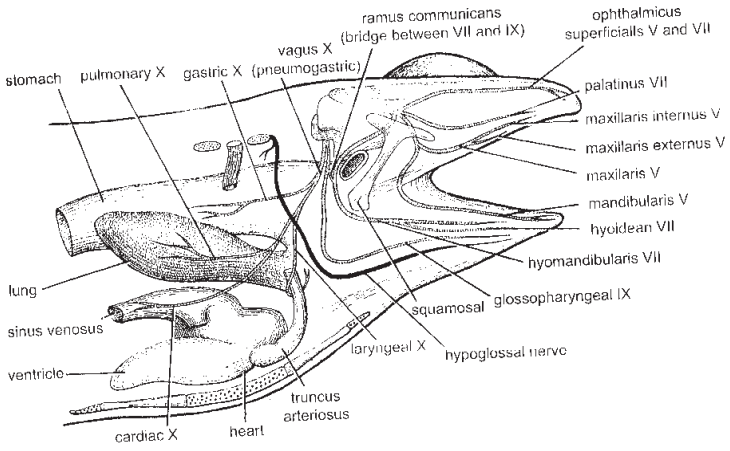


Fig 3.1 Model of Cranial nerve

11. **I or Olfactory nerve** is a sensory in nature, originates from olfactory lobe & innervated in nose epithelium.

12. **II or Optic nerve** is sensory in nature, originates from mid-brain ventrally & innervated in retina.

13. **III or Oculomotor nerveis** motor in nature, originates from ventral surface of mid brain & innervated in eye muscles.

14. **IV or Pathetic nerve or Trochlear nerve** is motor in nature, originates between optic lobes and cerebellum & innervated in muscles of eye.

15. **V or Trigeminal nerve**is mixed in nature, originates from side of medulla & it **has three branches:**

(v) **Ophthalmicssuperficialis**is sensory in nature & innervated in skin of snout.

(vi) **Maxillaris internus** are sensory in nature & innervated inskin and upper jaw.

(vii) **Mandibularis**is motor in nature & innervated in muscles of lower jaw.

16. **VI or Abducens nerve** is sensory in nature, originates from ventral side of medulla & is innervated in muscles of eyes.

17. **VII or Facial nerve,** originates from the side of medulla & it **has 2 branches**

(v) **Palatine Nerve** is motor in nature &innervated in roof of pharyngeal and buccal cavity.

(vi) **Hyomandibular Nerve** is motor in nature & innervated in tongue, lower jaw muscles and face

18. **VIII or Auditory nerve** is sensory in nature, originated from side of medulla & innervated in internal ear.
19. **IX or Glossopharyngeal nerve** is mixed in nature originated from medulla & innervated in tongue, pharyngeal
20. **X or Vagus nerve** is mixed in nature, originated from side of medulla and is innervated in general visceral organs

3.5.2 MODEL ON HYOID APPARATUS

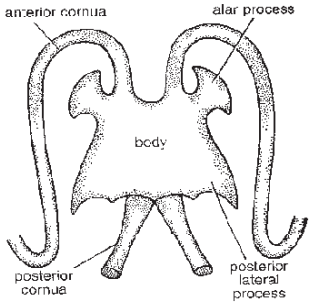


Fig. 3.2 Hyoid Aparatus

1. Hyoid Apparatus is located in the floor of the buccal cavity and between the two arms of the madibular arch.
2. Hyoid Apparatus is chiefly formed of a dorsoventrally flattened plate of 'Hyaline Cartilage'
   and a pair of rod like cartilage bones.
3. The broad central part of hyoid apparatus lying beneath the tongue is called the body of hyoid. On the two anterolateral sides of the body of hyoid there is a pair of flat wing like alary processes.
4. On the two posterolateral sides of the body of hyoid there is a pair a somewhat pointed processes called posterolateral process.
5. A pair of long, flat and thin anterior cornua arises from the anterior margin of the body of hyoid. A pair of posterior cornua arises from the posterior margin of the body of hyoid.

6. The opening of the glottis lies between the two posterior cornua. The hyoid apparatus provides surface for the attachment of tongue muscles and respiratory muscles. Thus the hyoid apparatus indirectly helps in the ingestion of food.
7. The hyoid apparatus brings about oscillating movement of the floor or the buccal cavity during the process of breathing.

3.5.3 MODEL ON BRAIN OF FROG

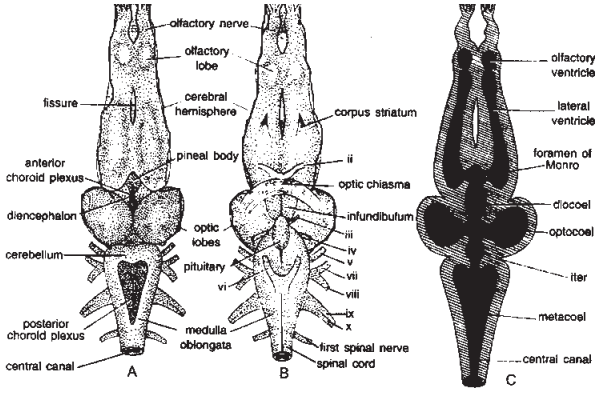


Fig. 3.3 Brain of frog

The frog's brain is divisible into three parts namely:

Fore-brain: It consists of olfactory lobes, a pair of cerebral hemispheres, and unpaired diencephalon. Olfactory lobe of frog's brain controls the sense of smell.

Mid-brain: The mid-brain of the frog is consists of a pair of optic lobes. Optic lobes are involved in the frog's vision.

Hind-brain: Hind-brain of the frog consists of cerebellum and medulla oblongata. Cerebellum helps to maintain the balance and equilibrium of the frog. The medulla oblongata passes out via the foramen magnum and continues into the spinal cord of the frog up to the tip of its trunk, which is contained in the vertebral column. Medulla oblongata helps in the regulation of respiration, digestion, and other autonomic functions. Cerebellum also controls the muscular coordination and posture.

3.5.4 MODEL ON COLUMELLA OF FROG

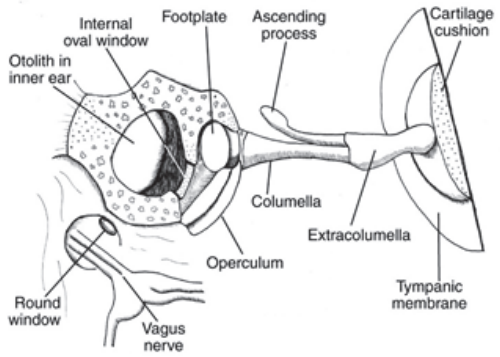


Fig. 3.4 Model on columella of frog

1.The ears of frogs consist of a tympanum, a middle ear and an inner ear.

2.The **tympanum** vibrates in response to sound waves and transmits these movements to the middle ear.

3. Touching the tympanum is a bony ossicle called **columella or stapes,** the opposite end of which touches the membrane of the **oval window,** which stretches between the middle and inner ear.

4. High frequency (1000 -5000 Hz) sounds strike the tympanum and are transmitted via stapes and cause pressure waves in the fluid of the semicircular canals. These waves in the inner ear fluid stimulate receptor cells.

5.A second ossicle, the operculum, also touches the oval window. Substrate transmitted through the front appendages and the pectoral girdle causes operculum to vibrate.

6.The resulting pressure waves in the inner ear stimulate a second patch of sensory receptor cells that is sescitive to low frequency (100 to 1000 Mz) sounds. Muscles attached to the operculum and columella can lock either or both of these ossicles, allowing a frog to screen out either high or low frequency sounds.

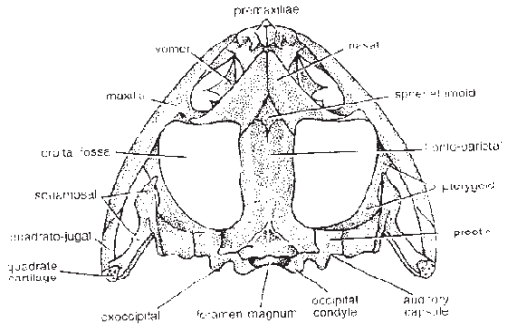
3.6 STUDY OF SKELETON OF FROG AND PERMANENT HISTOLOGICAL SLIDES OF AMPHIBIA

3.6.1 STUDY OF SKELETON OF FROG

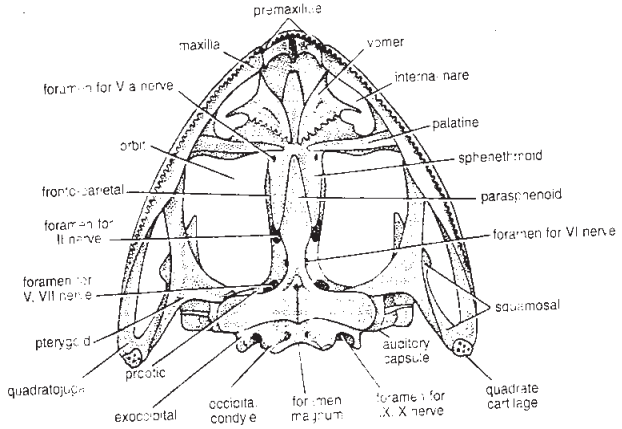
3.6.1.1 AXIAL SKELETON

(a) Skull of Frog:

1. Skull is triangular, dorso-ventrally flattened and broad.
2. Skull is Dicondylic.
3. Cranium is small & narrow.
4. Skull is platybasic.



(A) Dorsal view



(B) Ventral view

Fig. 3.5 Skull

(b) Disarticulated Skull Bones:-

1. **Occipital segment:**

1. Occipital segment is the posteriormost part of skull.

2. Dorsal side of occipital region is covered by fronto-parietal & floor is formed by parasphenoid.

3. A pair of bony exoccipital on lateral sides which enclose by a large opening called foramen magnum.

4. Each exoccipital bears an occipital condyle on its posterior surface.

5. Occipital condyles articulate with the atlas vertebra.

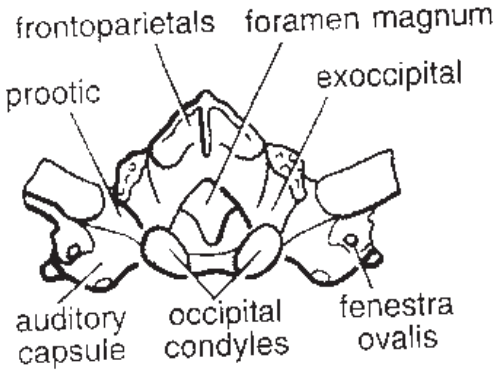


Fig 3.6 Occipital Segment

2. Fronto-parietals:

1. These are compound and membranous bone.

2. Formed by fusion of two frontals and two parietals.

3. Fronto-parietals extend in front overlapping the sphenethmoid.

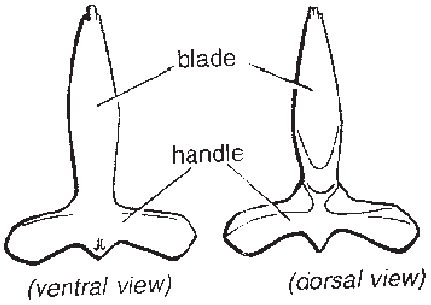


Fig 3.7 Fronto-parietals

3. Sphenethmoid:

1. A hollow tubular bone extending into the region of olfactory capsules.
2. Embossed with fronto parietals and nasals above and parasphenoid below.
3. Divisible into an anterior ethmoidal portion and a posterior sphenoidal portion.

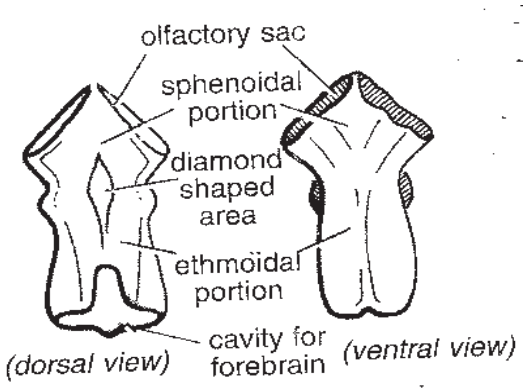


Fig 3.8 Sphenethmoid

4. Parasphenoid:

1. Parasphenoid is dagger or inverted shaped bone of skull.
2. It covers the floor of the cranium in the mid ventral line.
3. Blade is directed anteriorly and covers the sphenethmoid.

5. Vomer:

1. It is somewhat triangular bone lying below the nasal.
2. Posterior margin bears about 7 vomerine teeth.
3. It forms ventrally the floor of olfactory capsule and inner margin of the posterior nares.

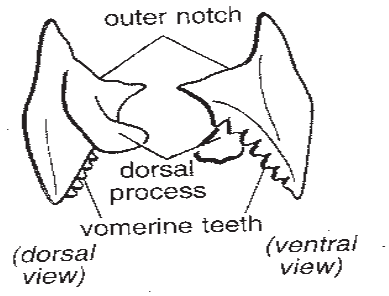


Fig 3.9 Vomer

6. Palatine:

1. Slender, rod-like bone lying just in front of the orbit on the ventral surface of skull.
2. Embossed with maxilla on outer end and sphenethmoid on inner end.

7. Pterygoid:

1. A triradiate bone or Y shaped bone lying almost opposite to the squamosal on the ventral side towards the posterior end of cranium.
2. Its anterior limb articulates with the maxilla
3. Inner limb joins with the para-sphenoid and auditory capsule.

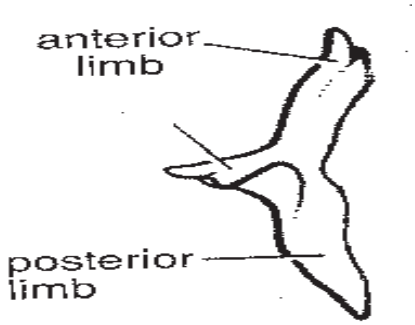


Fig 3.10 Pterygoid

8. Premaxilla:

1. Premaxilla is theanteriormost bone of upper jaw, found at the tip of snout.
2. A small irregular bone found in anterior portion of snout.
3. It has 2 rows of 5 and 4 conical teeth on ventral surface at anterior end.

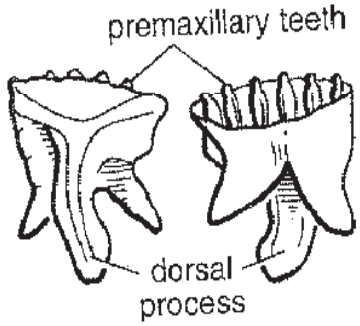


Fig 3.11 Premaxilla

9. Maxilla:

1. Maxillae forms the portion of outer margin of upper jaw.
2. A long, thin and slightly curved bone.
3. It has several minute, sharp, pointed and backwardly directed homodont teeth.

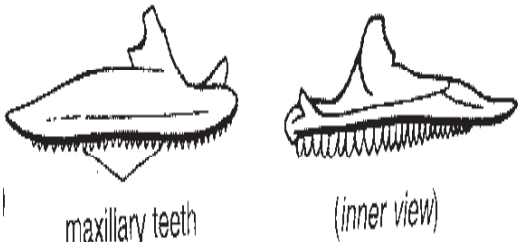


Fig 3.12 Maxilla

10. Quadrato-jugal:

1. It makes up the posterior portion of the outer margin of upper jaw.
2. A small, slender and coma shaped bone.
3. It is embossed anteriorly with maxilla and posteriorly with squamosals.

(a) Dorsal view (b) Ventral view

Fig 3.13 Quadratojugal

11. Squamosals:

1. T shaped bone lying on the dorso-lateral side of posterior end of cranium.
2. It consists of a backwardly directed handle and forward directly head.

12. Septo-maxillaries:

1. A Small irregular bone.
2. It contains basal plate and a pair of backwardly directed processes.
3. Located near the anterior process of each nasal.

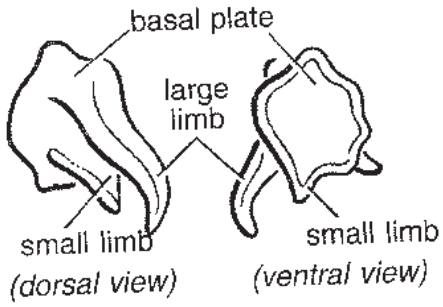


Fig 3.14 Septo-maxillaries

13. Nasals:

1. A large, flat, triangular and membranous bone covering olfactory capsule.

2. Found nearly on the mid-dorsal side of the skull and unites with its counterpart in the median line.

Fig 3.15 Nasals

14. Lower Jaw:

1. Lower jaw of frog is composed of two halves or rami.
2. Two rami are united anteriorly by a ligament.
3. Each half or ramus consists of three portions, mento-meckelian, dentary and Angulosplenial.

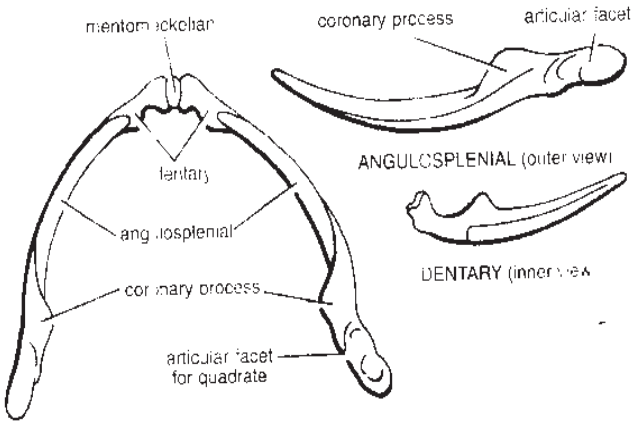


Fig 3.16 Muscles of Lower Jaw

14.1. Dentary:

1. A small, flat and dagger shaped bone of lower jaw.
2. No teeth in it.

14.2 .Angulosplenial:

1. A long, curved bone constituting inner and posterior portion of each ramus of lower jaw.
2. Anterior end is tapering, while it posterior end bears articular surface for the articulation.
3. Teeth are absent.

3.6.1.2 VERTEBRAL COLUMN

1. **Atlas Vertebra:**
    1. First vertebra
    2. Small and ring like form.
    3. Centrum and neural spine are reduced.
    4. Transverse process and prezygapophysis absent.

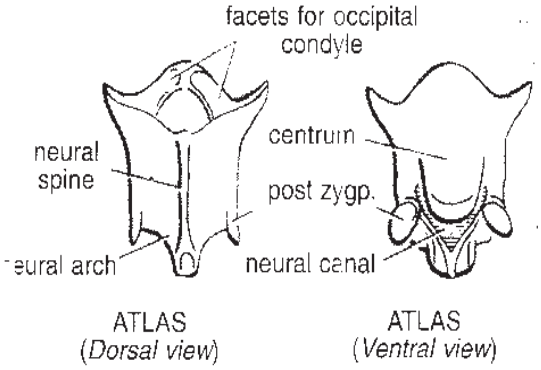


Fig 3.17 Atlas Vertebra

2. Typical Vertebra:

1. 2^{nd}-7^{th} vertebrae are typical in structure.
2. Centrum is procoelous (anterior surface concave & posterior surface convex).
3. It is ring in shape having a large hole called neural canal.
4. Neural canal bounded with neural arches.
5. Neural arches having large neural spine.
6. Transverse process is long, tapering and outwardly directed.
7. Pre zygapophyses and postzygapophyses are present

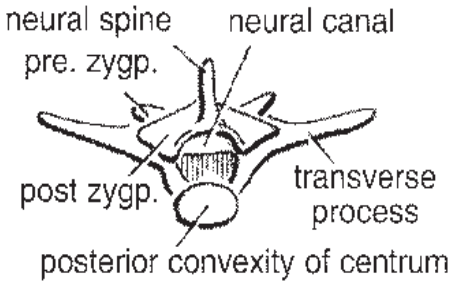


Fig 3.18 Typical Vertebra

3. Second Vertebra:

1. It is just like typical vertebra in structure
2. Short neural spine.
3. Transverse process is small, flat.

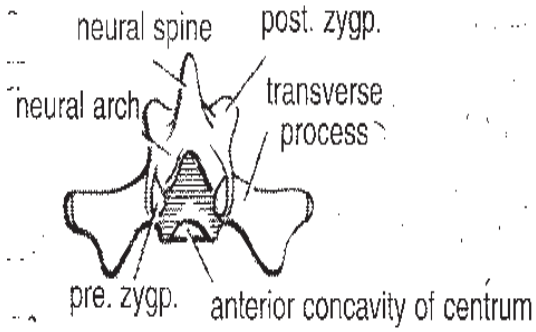


Fig 3.19 Second Vertebra

4. Fourth Vertebra:

1. It is also just like typical vertebra.
2. Transverse process are broad.

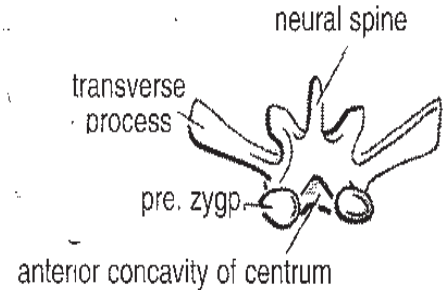


Fig 3.20 Fourth Vertebra

5. Eight vertebra:

1. Centrum is amphicoelous (both sides are biconcave).
2. Anterior concavity receives the posterior convexity of seventh vertebra.

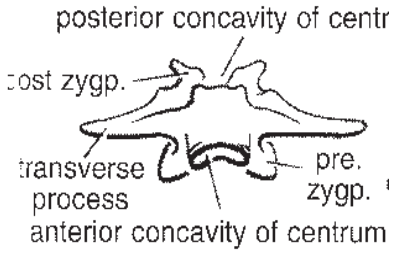


Fig 3.21 Eighth Vertebra

6. **Ninth vertebra:**
    1. It is known as sacral vertebra.
    2. Centrum is biconvex.
    3. Transverse process are cylindrical, stout and backwardly directed.
    4. Neural spine greatly reduced.

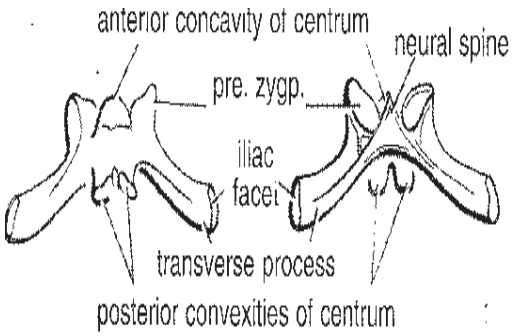


Fig 3.22 Ninth Vertebra

7. **Urostyle:**
    1. This is 10thvertebra showing the caudal region.
    2. Long and triangular having pointed tip & directed backwards.

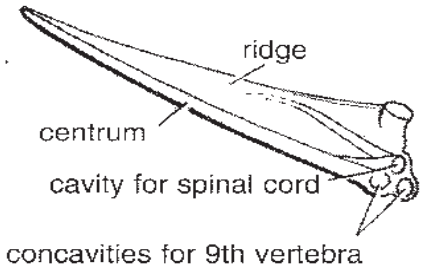


Fig 3.23 Urostyle

3.6.1.3 APPENDICULAR SKELETON

1. **Pectoral Girdle:**
    1. Found in thoracic region and give support to the fore-limbs.
    2. Each half is consist of scapular and coracoid portions.
    3. Two similar halves united mid-ventrallywith sternum and separated dorsally.

4. Scapular portion contains supra-scapula and scapula.
5. Supra-scapula is a thin cartilaginous plate on the dorsal side.
6. Scapula is flat contains a cup like glenoid cavity into which articulates the head of humerus.
7. Coracoid region having clavicle and coracoid and 2 cartilages- epicoracoid&precoracoid.

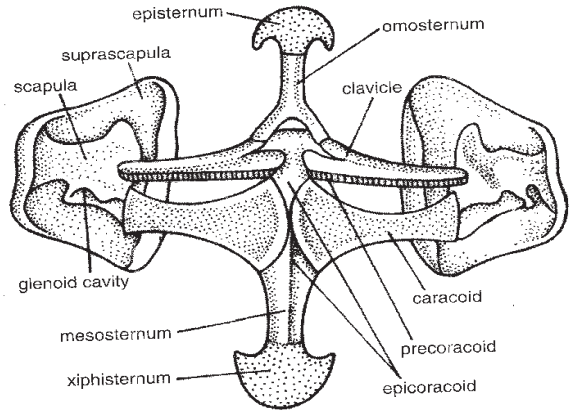


Fig 3.24 Pectoral Girdle

2. Pelvic Girdle:

1. Pelvic girdle found in the posterior side of trunk.
2. Each half of girdle is contains ilium, ischium and pubis. Two half join posteriorly to form V- shaped structure.
3. It provide support to the hind-limbs.
4. Ilium is long and joins with transverse process of ninth vertebra.
5. Pubis is a triangular piece of calcified cartilage. Pubic cartilages of both sides are completely fused.
6. Ischium is slightly oval bone, form posterior part of disc.

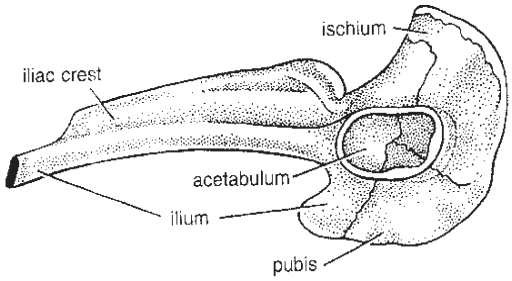
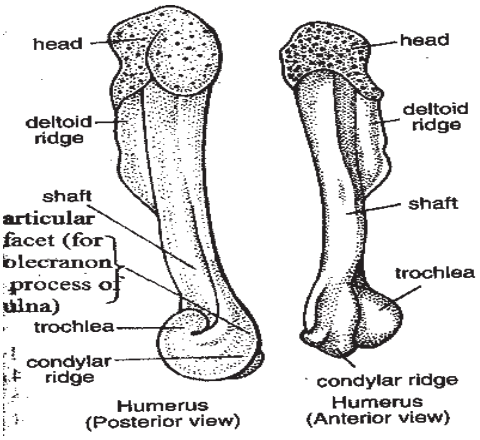


Fig 3.25 Pelvic Girdle

3.6.1.4 LIMB BONES

3.6.1.4.1 Forelimb bones:

1. **Humerus:**
    1. It is a bone of fore-limb found as a component of upper arm.
    2. A short, slightly curved and cylindrical bone.
    3. Proximal end is known as head and it fits into glenoid cavity of pectoral girdle.
    4. Distal end is attached to radio-ulna with condylar ridge.



(a) Posterior view (b) Anterior view

Fig 3.26 Humerus

2. **Radio-ulna:**
    1. This is a compound bone of fore-limb, consist of radius and ulna.
    2. Proximal end contains a concavity to receive the trochlea of humerus.
    3. Ulna projects into an olecranon process.

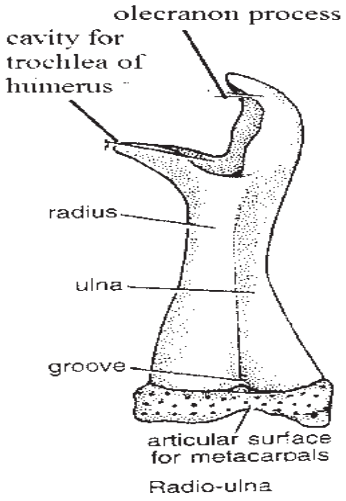


Fig 3.27 Radio-ulna

3. Bones of Hand:

1. Wrist bone is called as carpals.
2. Carpal bones are six in number and arranged in two rows with three at each rows.
3. Bone of the proximal rows is ulnare, intermedium and radiale, articulates with radio-ulna.
4. Bone of distal row is called capitohamatum, trapezoid and trapezium, articulates with metacarpals.
5. Hand has five slender metacarpals, bears five digits having 2, 3, 4, 5 and 3 phalanges with claws.

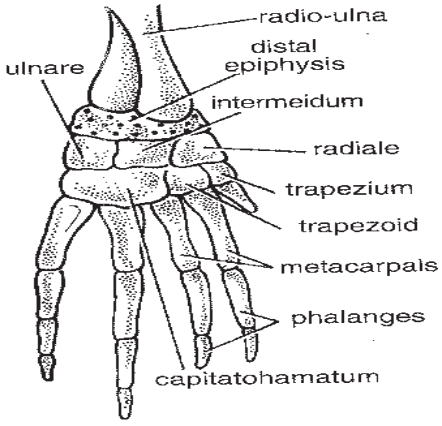


Fig 3.28 Bones of Hand

3.6.1.4.2 Hind limbs:

1. Femur:

1. Bone of thigh region of hind-limb.
2. Long and slender having a slightly curved shaft.
3. Proximal swollen end is called head.
4. Head fits into the acetabulum of pelvic girdle.

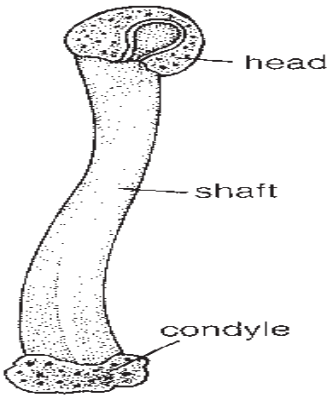


Fig 3.29 Femur

2. Tibio-fibula:

1. Compound bone of shank region of hind limb.
2. Formed by fusion of tibia and fibula bones forming a single bone.
3. Proximal and distal ends are covered by cartilage.

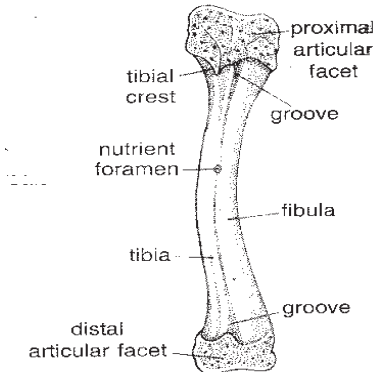


Fig 3.30 Tibio-fibula

3. Astragalus-calcaneum:

1. Astragalus-calcaneum is a compound bone of ankle of hind – limb.
2. Ankle consists of two rows of four bones.
3. Inner bone is thinner and slightly curved called astragalus.
4. Outer thicker and straight bone is called calcaneum.

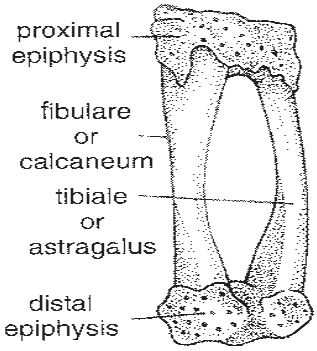


Fig 3.31 Astragalus-calcaneum

4. Bones of foot:

1. Foot of frog has 5 metatarsals having 5 true toes.
2. Metatarsals are long and slender bones.
3. First, second, third, fourth and fifth metatarsals having 2, 2, 3 ,4& 5 phalanges respectively.
4. Pre axial sixth toe is called prehallux.

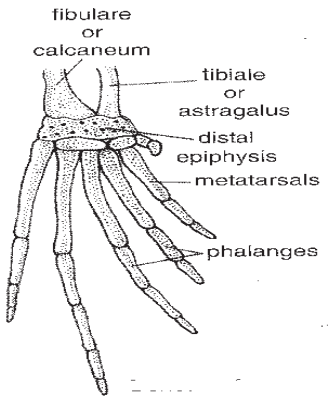


Fig 3.32 Bones of Foot

3.6.2 PERMANENT HISTOLOGICAL SLIDES OF AMPHIBIAN

1. V.S. of Skin of frog:-

Comment:

1. Outermost surface has a skin devoid of exoskeleton.
2. Skin is made up of two layers i.e., epidermis and dermis.
3. Epidermis is made up of stratified squamous epithelium; it is composed of two layers
   (a) Outermost layer- stratum corneum.
   (b) Inner layer- stratungerminativum or stratum Malpighi.
4. Basement membrane is located between epidermis and dermis. .
5. Largely of connective tissues occur in dermis layer, it is composed of 2 layers-
   (a) Outer- spongy layer made up of loose connective tissue & contains mucous glands, poison glands and chromatophores.
   (b) Inner- compact layer
6. Dermis also having vertical fibres, blood vessels, nerves & lymph space.

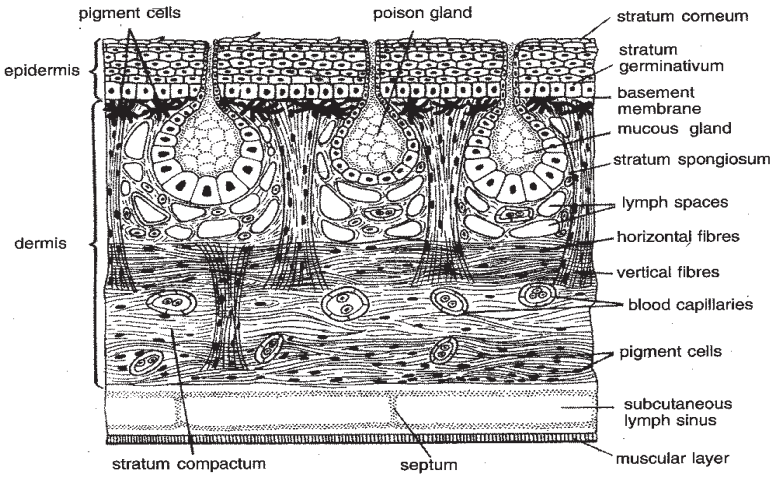


Fig 3.33 Skin of Frog

2. T.S of intestine of frog

Comments:

1. It contains layer of serosa, muscularis, submucosa and mucosa.
2. Serosa is very thin and made up of peritoneal cells.

3. Muscularishaving longitudinal muscle fibres(Outer layer) and circular muscle fibres(Inner Layer).
4. Submucosa composed of loose connective tissue fibres and contains nerves, lymph spaces and blood vessels.
5. Mucosa composed by simple columnar epithelium & having numerous simple folds or villi.

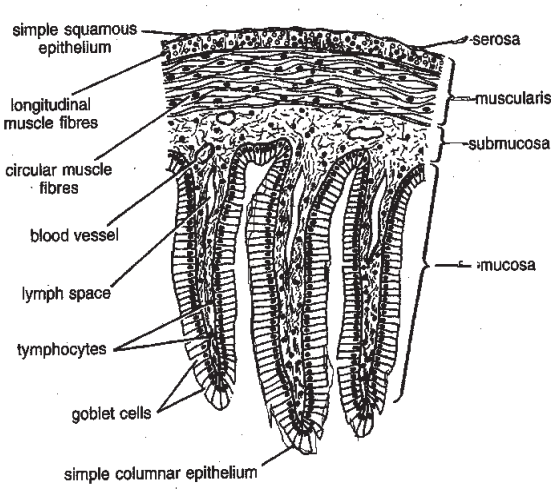


Fig 3.34 Intestine of Frog

3. T.S of liver of frog:-

Comments:

1. Liver contains a large number of hepatic acini which shows in section lined by hepatic cells.
2. Hepatic acini are made up of granular columnar hepatic cells surrounding bile canaliculi in centre.
3. Each hepatic cell having a prominent nucleus and granular cytoplasm.
4. Bile canaliculi together to form the bile ductules, then to form bile duct.
5. Blood capillaries and sinusoids are seen among the acini.
6. sinusoids are lined by phagocytic cells (Kupffer cells).

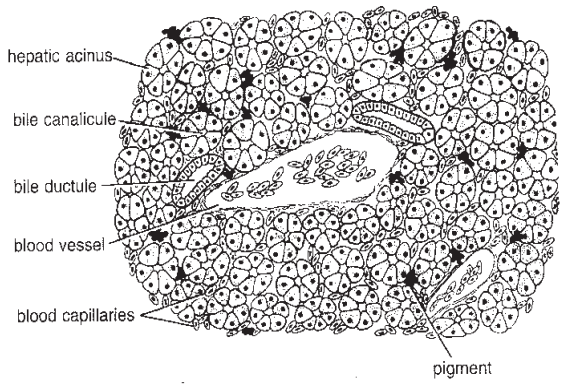


Fig 3.35 Liver of Frog

4.T.S of pancreas of frog:-

Comments:

1. Pancreas is branched and looks like grape- bunched.
2. A series of pancreatic lobules are seen.
3. Each lobules contains a group of many secretory cells, they encircle a very narrow central lumen.
4. Cavities of these lobules communicate each other and finally discharge into the bile duct as it passes through pancreas.
5. A scattered groups of cells are found between pancreatic lobules knows as Islets of Langerhans.
6. Islets of Langerhans are small prism shaped cells without lumen. They are of 3 types-
   (i) alpha (ii) beta and (iii) delta cells
7. Blood Vessels are found in and around the Islets of Langerhans.
8. Pancreas perform exocrine as well as endocrine function.

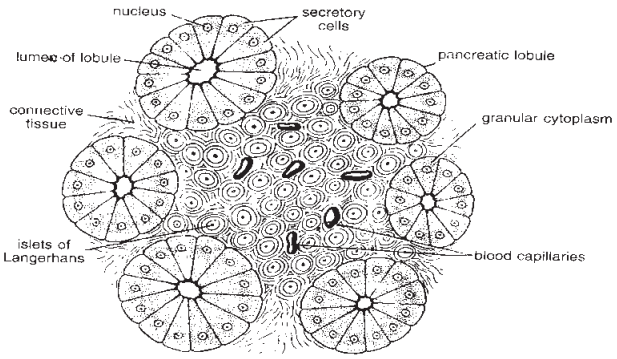


Fig 3.36 Pancreas of Frog

5. T.S of lung of frog:-

Comments:

1. Lung outer wall is made up of connective tissue known as peritoneum.
2. Central cavity is partly divided into numerous chambers or alveoli partitioned by trabeculae.
3.Trabeculae are partially surrounded by simple squamous epithelium and ciliated columnar epithelium.
4. Blood vessels and capillaries are innervated in trabeculae walls.
5. Numerous bundles of muscle fibres are present within the trabeculae.
6. Elastic fibres present in the outer wall of lungs gives a remarkable power of contraction and expansion.
7. Trabeculae & Alveoli increase the respiratory surface.

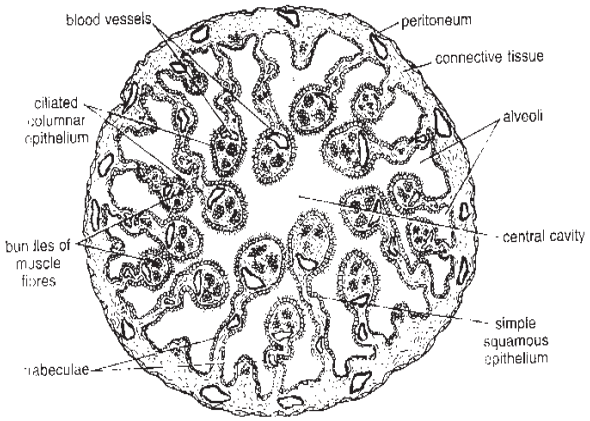


Fig 3.37 Lungs of Frog

6. T.S of Kidney of Frog:-

Comments:

1. Kidney enclosed in a fibrous connective tissue capsule & in venral side is covered by visceral peritoneum.
2. Uriniferous tubules are found inside kidney in large number.
3. Bowman's Capsule are cup –shaped structure.
4. Tuft of blood vessels, formed within the Bowman's capsule is known as glomerulus.

5. Bowman's capsule leads into a uriniferous tubule which is convoluted and ultimately opens into collecting tubule.

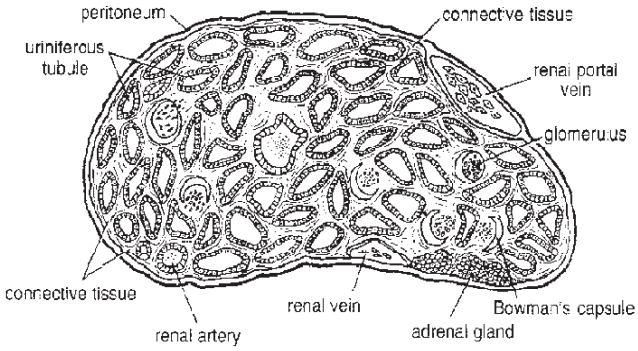


Fig 3.38 Kidney of Frog

7. T.S of Testies of Frog:-

Comments:

1. The seminiferous tubules are lined by a single layer of cuboidal cells. These cuboidal cells form

the germinal epithelium.

2. The germinal epithelium produces a large number of sperms through the process ofspermatogenesis.

3. The sperms can be seen in the form of several bundles. These bundles are radially arranged in the lumen of each seminiferous tubule.

4. Spermatogonia, spermatocytes and spermatids are seen in the slide.

5. Connective tissue contains interstitial cells responsible for appearance of secondary sexual characters.

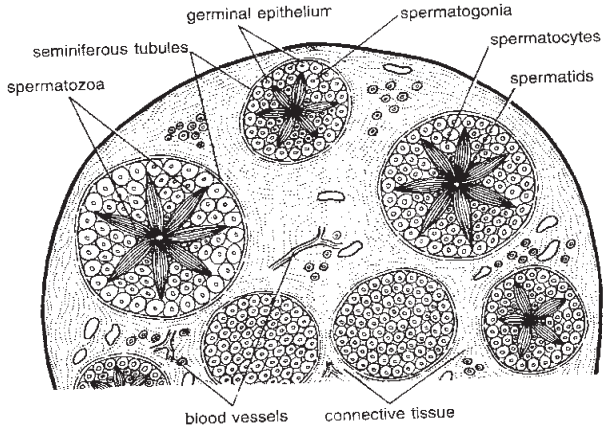


Fig 3.39 Testies of Frog

8. T.S of Ovary of frog:-

Comments:

1. Ovary has a large number of hollow lobes or lobules.
2. Each lobule is covered externally by theca externa.
3. Few follicles of different sizes are connected to the theca externa.
4. Ova are formed in lobules, Each ovum has nucleus, yolky granular cytoplasm& follicular cells.
5. Fully matured ova surrounded by follicular epithelium (vitelline membrane).
6. These cells form ovarian stroma which secretes ovarian hormones.

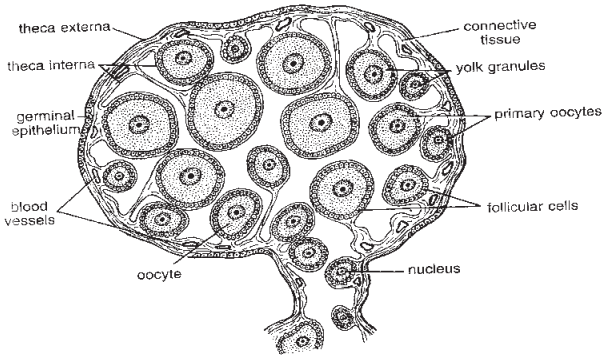


Fig 3.40 Ovary of Frog

3.7 STUDY OF MUSEUM SPECIMENS

1. Salamandra:

General Characters:

1. *Salamandra* is commonly known as fire –salamander.
2. They are terrestrial in nature.
3. Body is lizard like. Males are shorter than female.
4. Color of body is black with yellow spots.
5. Limbs are well developed and strong.Tail is cylindrical.
6. Gills are absent in adults.
7. Eye-lids are moveable.
8. Paratoid glands are present behind the head.
9. Inter-auricular septum is perforated.
10. About 15 embryo develops in the oviducts.

11 Young –ones are born with having external gills and metamorphosis take place.

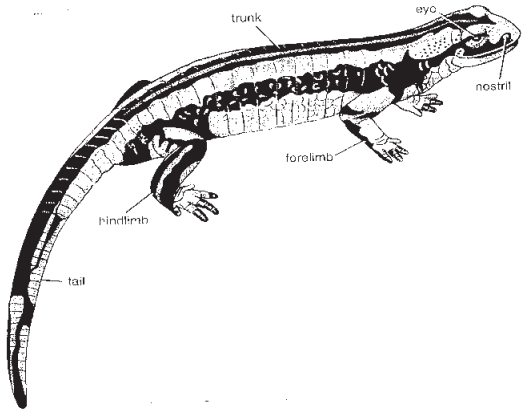


Fig 3.41 Salamandra

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of

appendages; circulatory system closed , blood is red in
color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia -- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Urodela/caudata--- Body with distinct head, trunk and tail; limb two pairs of equal size; oviparous. Larvae aquatic like adults.

Genus : *Salmandra*

2. *Proteus*

General Characters:

1. *Proteus* is commonly known as Blind-cave salamander or olm.
2. Body is elongated eel type reaches upto length of about 45 cm.
3. Skin unpigmented.
4. Eye are absent.
5. Teeth are present in both jaws.
6. Limbs are small and poorly developed, fore limbs contains only 3 digits and hind limbs contains only 2digits.
7. Three pair of branching external gills and two pairs of open gill clefts are present in adult.
8. Tail is compressed and has a caudal fin.
9. Lungs are also present.

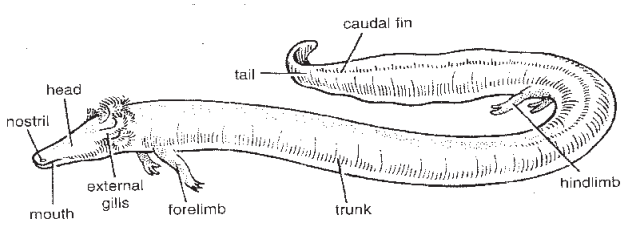


Fig 3.42 Proteus

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-

slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of externalscales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs ofequal size; oviparous. Larvae aquatic like adults.

Genus : *Proteus*

3. *Amphiuma*

General Characters:

1. *Amphiuma* is commonly called Congo-eel.
2. They are found in swamps and muddy water.
3. Body is very long and cylindrical measuring about 90 cm in length.
4. Fore and hind limbs are not used for locomotion because both the limbsare less developed and almost vestigial.
5. Eyes are well developed and lidless
6. Lungs with long trachea supported by cartilages.
7. Sternum is absent.
8. They lay its eggs in water and female coils around them for protection.

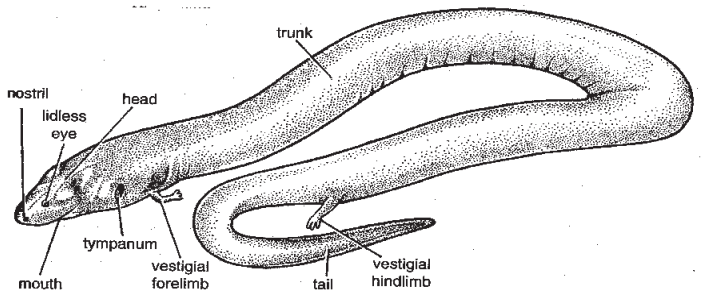


Fig 3.43Amphiuma

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs of equal size; oviparous. Larvae aquatic like adults.

Genus : *Amphiuma*

4. *Necturus*:

General Characters:

1. *Necturus* is commonly called water dog or mud-puppy.
2. Body is elongated measuring from 30- 42 cm in length.
3. Head is depressed and contains small eyes without eyelids.
4. Tail is long & compressed and bears caudal fin.
5. Their color is rusty brown with black spots.
6. It exhibits permanent neotenic larva characteristics.
7. Lungs present.

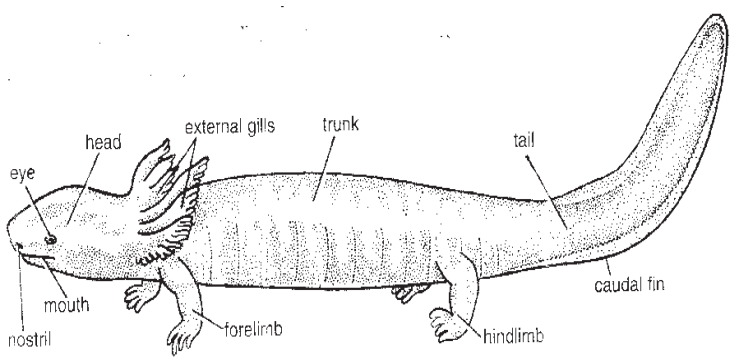


Fig 3.44Necturus

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs Ofequalsize; oviparous. Larvae aquatic like adults.

Genus : *Necturus*

5.*Siren*

General characters:

1. *Siren* is commonly known as mud –eel.
2. Body is elongated eel like, measuring about 75-90 cm in length.
3. It is a permanent larval form but exhibits few adult features.
4. Eyes are lid less.
5. Jaws are provided with horny covering. Teeth are absent in both jaws.
6. Three pairs of external gills are present.
7. Fore limbs are small contains four finger and Hind limbs are entirely absent.
8. Tail has a caudal fin.
9. Fertilization is external.

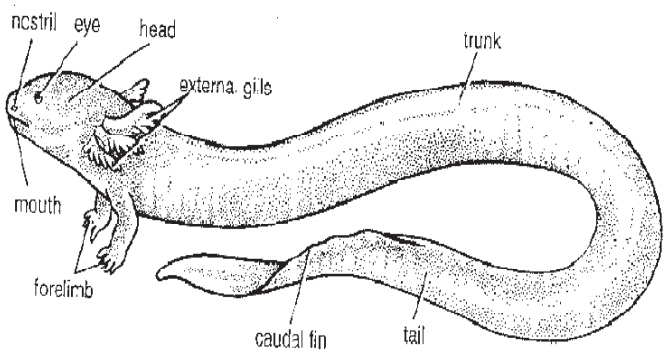


Fig 3.45 Siren

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs of equal size; oviparous. Larvae aquatic like adults.

Genus : *Siren*

6. *Ambystoma*:

General Characters:

1. *Ambystoma* is commonly known as Tiger –salamander or spotted salamander.
2. Body is elongated and lizard like, about 12-18 cm in length.
3. Skin is poisonous.
4. Limbs are well developed. Fore limb with 4 digits and hind limbs with 5 digits.
5. Tail fin and external gills are absent in the adult stage.
6. Sex is separate.

7. Fertilization is internal.
8. Fertilized eggs developed into an Axolotl larva.

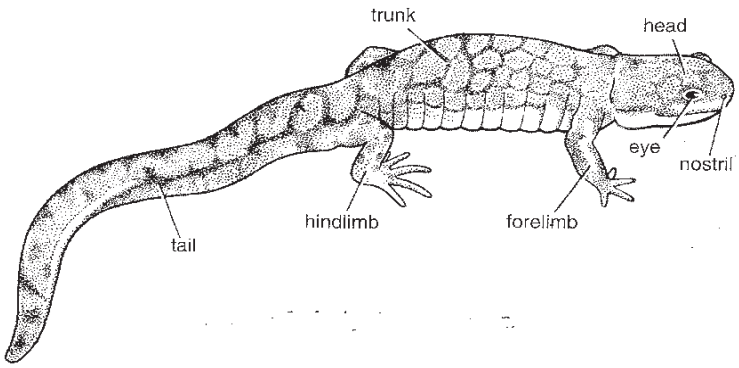


Fig 3.4 6Ambystoma

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in colorcontaining R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs of equal size; oviparous. Larvae aquatic like adults.

Genus : *Ambystoma*

7. *Axolotl larva*:

General Characters:

1. *Axolotl* is the larva of *Ambystoma*.
2. It has3 pairs of external gills and tail is provided with caudal fin.

3. They exhibit the phenomena of neotony (failure to metamorphose if food supply is insufficient).
4. They can also undergoes metamorphosis if environmental conditions are changed.
5. They become sexually mature and reproduces Paedogencais when thyroid gland action is inhibit due to change in environmental conditions.
6. Metamorphosis is induced by injecting thyroid extract or by transferring to water with a higher iodine content.
7. Gills and tail fin are lost when undergoing metamorphosis.

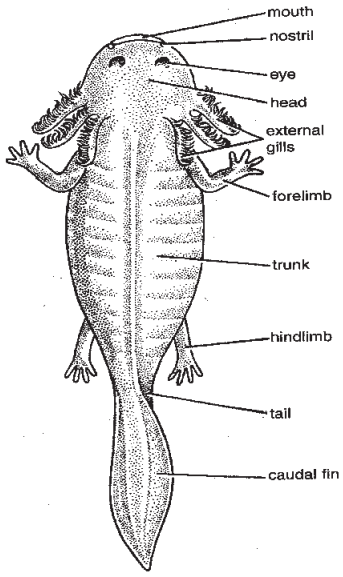


Fig 3.4 7 Axolotl Larva

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in colorcontaining R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of

external scales; heart three chambered

Order : Urodela/caudata --- Body with distinct head, trunk and tail; limb two pairs of equal size; oviparous. Larvae aquatic like adults.

Genus : *Axootl Larwa*

8. *Rhacophorus*:

General Characters:

1. *Rhacophorus* is commonly known as Flying Frog.
2. Body is slender.Head is broad and nearly conical, bearing eyes, nostrils and tympanum.
3. Limbs are long and thin with large feet and well developed web in digits.
4. Digits of feet bear rounded adhesive pads or discs.
5. These flying frog can leap 6-10 meters in the air.
6. It also exhibits parental care by depositing eggs in the nests near water.
7. It has the capacity to change the color rapidly.

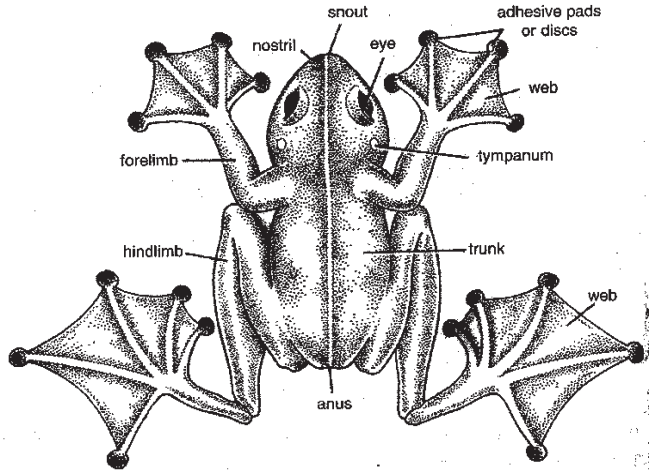


Fig 3.48 Rhacophorus

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in
color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Anura/Salientia --- Tail, external gills &gill slits absent, both the limbs are well developed.

Genus : *Rhacophorus*

9. *Alytes*:

General Characters:

1. Alytes are commonly called mid-wife toad.
2. It measures 5 to 8 cm in length.
3. Eyes having movable eyelids.
4. Tympanum is large.
5. Males are without vocal sacs.
6. Fore limb have4 fingers and hind limbs have 5 toes.
7. They exhibits parental care.
8. Fertilization external.

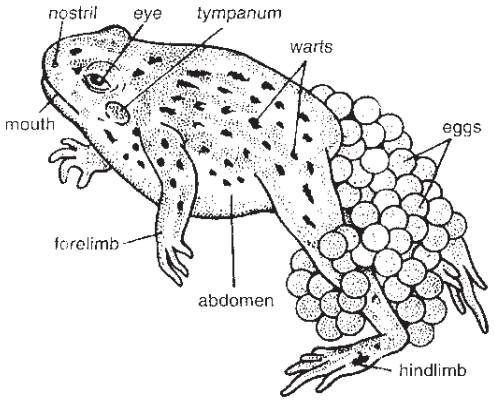


Fig 3.49Alytes

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Anura/Salientia --- Tail, external gills &gill slits absent, both the limbs are well developed.

Genus : *Alytes*

10. *Hyla*

General Characters:

1. They are commonly known as tree frog.
2. Skin is smooth on the dorsal surface but bears papillae on the ventral surface.
3. Animal measure 2.5 to 8 cm in length.
4. Eyes, nostrils and tympanum are well developed.
5. Fingers and toes have adhesive pads or cushions which used to climb trees.
6. Web is poorly developed.
7. Vocal sacs are greatly expanded and produce loud voice.
8. Vertebrate are procoelous.
9. They show mimicry.
10. Eggs are carried on the back of female.

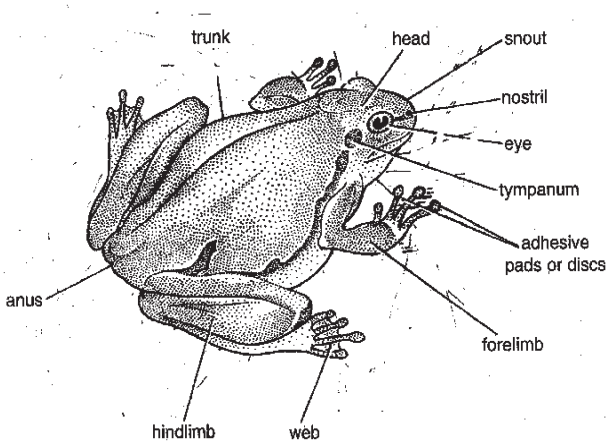


Fig 3.50 Hyla

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Anura/Salientia --- Tail, external gills &gill slits absent, both the limbs are well developed.

Genus : *Hyla*

11. *Pipa*:

General Characters:

1. *Pipa pipa* is commonly called Suriname Toad.
2. Dermal papillae are present and poison glands are present at its base.
3. Head is triangular and depressed with a pair of small tentacles in front of eyes.
4. Tongue & eyelids are absent.

5. Tympanum is not distinct.
6. Eustachian tubes open into the pharynx.
7. Fore-limbs finger are ending in a star shaped tips having sensory processes.
8. Hind limbs are large and broadly webbed.
9. Eggs undergo complete transformation at the back of female.

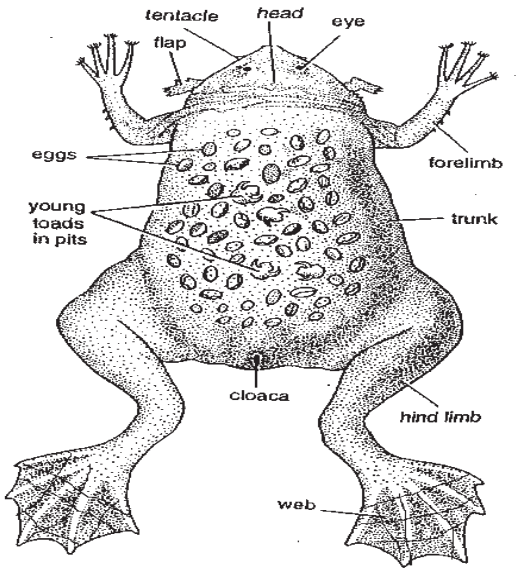


Fig 3.51 Pipapipa

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered

Order : Anura/Salientia --- Tail, external gills &gill slits absent, both the limbs are well developed.

Genus : *Pipa*

12. *Bufo*

General Characters:

1. Bufo is commonly known as true toad.
2. Dorsal surface of the body is rough, dry and watery.
3. Eye are large and nostrils are very small.
4. Well developed Tympanum.
5. One paired parotid poison glands are present.
6. 3 webless fingers and a thumb pad (adhesive pads) are present in forelimbs while Hind limbs bears 3 digits.
7. Eggs are pigmented & laid in gelatinous strings.
8. They are carnivorous feeding on worms, insects and snails.

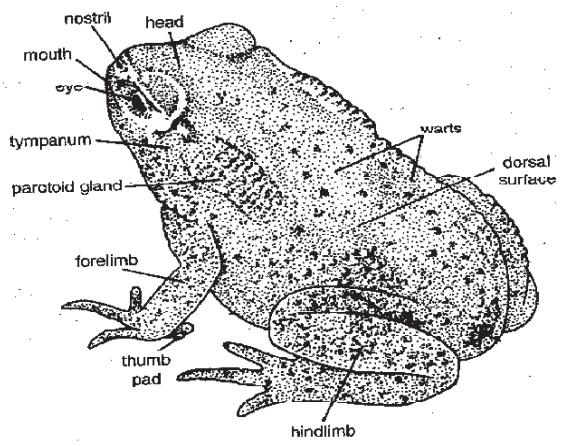


Fig 3.52 Bufo

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- Definite head, cranium with brain present.

Subphylum : Vertebrata --- Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata --- Jaws and paired appendages are present

Class : Amphibia --- Cold blooded; skin moist, soft glandular and devoid of external scales; heart three chambered.

Order : Anura/Salientia --- Tail, external gills &gill slits absent, both limbs are well developed.

Genus : *Bufo*

3.8 SUMMARY

Class amphibia (Gr., amphi=both ; bios = life) includes vertebrate animals such as Frog, Toad, Salamandaretc which inhabits both land and water. They have two stages: Larva tadpole (usually aquatic) and adults(mostly terrestrial), with nearly 2,500 species found near water source.

Class Amphibia has been divided into two sub class:Stegocephalia and Lissamphibia. These two sub class have been divided on the basaic of dermal bones. Stegocephaliaincludes extinct lizard like or salamander like amphibian with dermal bones. Lissamphibia have modern amphibian traits with simple teeth and no dermal bones.

Amphibians are cold blooded, carnivores, oviparous, can breathe in air and water both. Their body is divided into head and trunk with neck, tail may be present or absent. Skin is scaly, rich in glands to keep it moist.

They population is a good indicator of health of the ecosystem. They are quite susceptible to change in environment, ecological degradation.

Amphibians are of special importance to mankind. They are used in scientific study (specially frog and toad), food (frog, necturus, a*xolotl*, salamanders), medicinal drugs, production of poisonous substance. They feed on several Harmful insects keeping control on their population. Skins and their larva are used for making glue, purses and motifs in art.

3.9 GLOSSARY

Appendage: Portion of the body that projects and has a free end, such as limbs.

Arboreal: Pertaining to trees or tree-living.

Neotony: larval state which is permanent and sexually mature.

Notochord : Rod like cellular skeletal axis found in chordate embryo or adult, mid-ventral to nerve cord.

Opisthocoelous: Vertebrae in which the centrum is convex and the posterior is concave.

Oviparous: Egg lying animal

Pentadactyle: Having five fingers toes or digits.

Pharynx: Anterior portion of the digestive tract between the mouth cavity and the oesophagus.

Procoelous: concave at the anterior end of centrum and convex at the posterior end of the centrum.

Sternum: Breast bone

Tetrapod: Four limbed vertebrate.

Tympanum: Vibrating membrane involved in the sense of hearing.

Vestigial: Degenerate structure that was better developed or functional in more primitive or ancestral group of animals.

3.10 SELF ASSESMENT QUESTION

1. Amphibians are animals which can live:
   (a) Only On land (b) Only on water (c) Both on land and water (d) Estuarine water.
2. A feature of Amphibians is:
   (a)Webbed limbs (b) Presence of dermal scales on the skin (c) Presence of glandular and moist skin without scales (d) Presence offins.
3. Which one of the following is not present in Amphibian?
   (a) Head (b) Neck (c) Trunk (d) Tail.
4. Tree Frog is common name of

(a) *Hyla* (b) *Proteus* (c) *Siren* (d) *Necturus*.

5. *Necturus* is commonly known as

(a) Tree Frog (b) Mud Puppy (c) Congo eel (d) Surinam toad

6. *Rhacophorus* is commonly known as

(a) Tree Frog (b) Congo eel (c) Flying frog (d) Surinam Toad

7. Neoteny is shown by

(a) *Proteus* (b) *Siren* (c) *Ambystoma* (d) All.

8.Distribution of Amphibians is worldwide excepts in

a) Sweden (b) New Zealand (c) Antarctica and Greenland (d) Finland.

9.*Salamandra* is a member of class

(a) Amphibians (b) Reptilia (c) Aves (d) Mammals

10. Axolotl is the larva of :

(a)*Ambystoma* (b) *Proteus* (c) *Siren* (d) *Pipapipa*.

11. Absence of neck in frog helps it in

(a) Swimming (b) Climbing (c) Capturing of prey (d) Jumping.

1(c) 2(c) 3(b)4(a) 5(b)6(c) 7(d) 8(c) 9(a) 10(a) 11(d)

3.11 REFERENCES

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- **Lal, S. S. (2015)**: Practical Zoology Vertebrate .Rastogi Publications. Meerut.
- **Pandey, B**.N. (2015): Animal diversity volume 1, Tata McGraw Hill Education Private Limited.

3.12 SUGGESTED READING

- Cleveland Hickman, Jr. Larry Roberts, Susan Keen, Allan Larson and David Eisenhour(2015): Animal diversity, 7th edition, McGraw Hill Education Private Limited.

3.13 TERMINAL QUESTION

1. What purpose Frogs have long sticky tongues
   They use tongues to catch prey like insects.
2. Why amphibians lives in wet or damp conditions?
   Skin of amphibians lacks shell, scales or outer dried covering, so they live in wet or damp Places to prevent dehydration.
3. Toads have rough skin
   Toads have special structure in their skin that secretes poisonous fluids, and these structure make their skin bumpy.
4. How Frog are good bio-indicators.
   Frog are good bio-indicator because---
   (i) They have permeable skin that allows free movement of substance into the body.
   (ii) Can absorb and concentrate toxins in their fatty tissues.
   (iii) They spend one part of their life on land and other in water.
5. How Life Cycle of amphibians is more complex in comparison with other vertebrates.
   The life cycle of amphibians is complex on account of :
   1. Selection of breeding grounds.
   2. Appropriate climatic condition.
   3. Courtship. (Amplexus)
   4. Type of fertilization. (External)
   5. Type of metamorphosis.
6. How Frog is an ideal animal for vertebrates study.
   This is because of the following reason:
   1. Universally distributed.
   2. Symmetry in body cavity.

7. How Frog differs from Toad.

   They differ by

   a) Frog are diurnal while toads are nocturnal.
   b) Frogs are mostly aquatic, but come on land for feeding while vice versa is for toad.
   c) Frogs lay eggs in masses while toads lay eggs in line like gorland.

8. For what purpose does Tree Frog have adhesive pads on the toes of feet.

   They use adhesive pads to clamp with the tree while climbing trees.

UNIT 4: CLASS- REPTILIA

CONTENTS

4.1 OBJECTIVES

By the end of this chapter, you will know

1. General characteristics of Reptiles.
2. Classification up to order level
3. Study of skeleton of Reptiles by taking Varanus as an example.
4. Study of museum specimen of Reptiles.

4.2 INTRODUCTION

Reptile are vertebrates within class Reptilia.The word Reptilia(L.repere or reptum "crawl").They are cold blooded, skin covered with scales, breathing with lungs, completely bony skeleton.All reptile have 3 chambered heart except crocodile. Majority of species are terrestrial.

4.3 GENERAL CHARACTERS

1. Body covered with dry skin having a few cutaneous glands and high levels of keratin, which prevents water loss.
2. Hind and forelimbs present.
3. Cold blooded
4. Horny epidermal scales, shields, plates and scutes form exoskeleton.
5. Single occipital condyle.
6. Respiration by lungs.
7. Heart is three chambered and four chambered in crocodile.
8. Typical cloaca is present.
9. Fertilization internal.
10. Bony endoskeleton.
11.

4.4 CLASSIFICATION UPTO ORDER LEVEL

Sub class (A) Anapsida

1. Skull roof solid.
2. Limbs are generally strong.

Order 1: Cotylosauria

1. Primitive reptiles.
2. Resemble Labyrinthodont amphibians.

Example. *Seymouria*

Order 2: Chelonia

1. Body covered with a firm shell of rounded dorsal carapace and flat ventral plastron.
2. No teeth. Jaws with horny sheath.

Example: *Kachuga*

Sub class (B) Eurypsida

1. Skull with single dorsolateral temporal opening bounded by post orbital and squamosal.
2. Extinct

Example: *Plesiosaurus*

Sub class (C) Parapsida

1. Dorsolateral temporal opening in skull bounded by supra-temporal and post frontal.
2. Extinct.

Example: *Ichthyoaurus*.

Sub class (D) Synapsida

1. Skull roof with lower opening behind eye bounded above by post –orbital and squamosal.
2. Extinct mammal like reptiles.

Example: *Dimetrodon*

Sub class (E) Diapsida

1. Skull roof with 2 openings behind eye separated by a bar formed by post-orbital and squamosal.
2. No antero-orbital opening or depression.

Order 1: Rhynchocephalia

1. Two vacuities are present.
2. Scales granular, mid dorsal row of long spines.

Example: *Sphenodon*

Order 2: Squamata

1. Body is covered by horny epidermal scales or shields.
2. Limbs present (Lizard) or absent (Snakes).

Example: *Chameleon, Varanus*

Order 3: Crocodilia

1. Body is covered with an exoskeleton of thick horney epidermal shield.
2. Jaws powerful with teeth.

Example: *Crocodile, Alligators*

Order 4: Pseudosauria

1. Extinct

Example: *Saltopseudois*

Order 5: Saurischia

1. Ischium and public diverge.
2. Bipedal or huge 4 footed.

Example: *Dinosaurs, Diplodiscus*

Order 6: Oranithischia

1. Pelvis bird like.
2. Ischium and pubis together.

Example: *Dinosaurs*

Order 7: Pterosauria

1. Flying reptiles
2. Forelimbs with wing membranes

Example: *Pteranodon*

4.5 STUDY OF SKELETON OF VARANUS

(A) Axial Skeleton:

1.Skull

1. The skull is compact and having the narrow anterior end.
2. It is monocondylic.
3. It is tropibasic.
4. Temporal region has t fossae on either side, the supra-temporal fossa,supra-orbital fossa and sub-orbital fossa.
5. Lower jaw attached with quadrate bone of the skull.
6. There are 6 bones in lower jaw.
7. Cranium has three region: a) Occipital segment b) Parietals c) Frontals

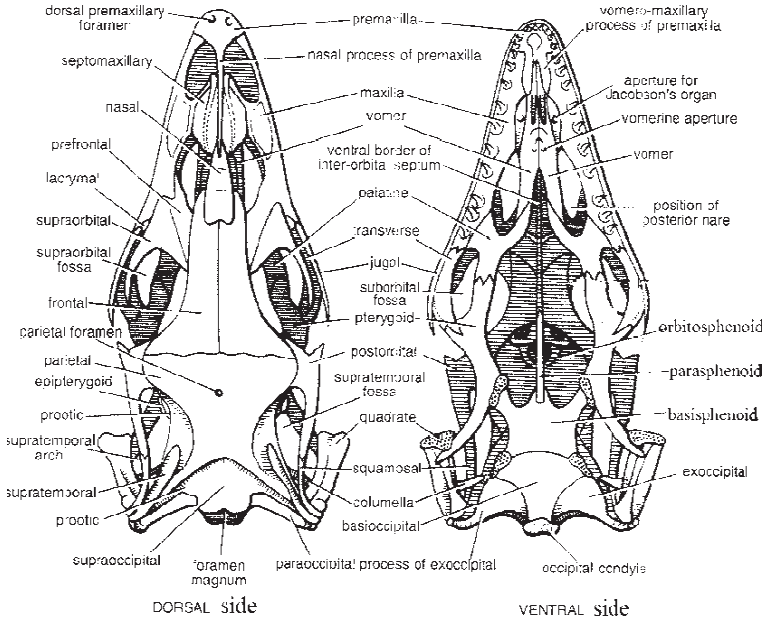


Fig. 4.1 Skull

2. Disarticulated Skull Bones:-

(a) Occipital segment:

1. It is the posterior part of cranium.

2.It encompasses foramen magnum in its centre.

3. The segment comprises of four bones i.esupraoccipital, basioccipital and paired exocciptals.

4. Occipital segment articulates posteriorly with the atlas vertebra by the occipital condyle.

5. All Bones of Occipital region are fused forming a ring like structure.

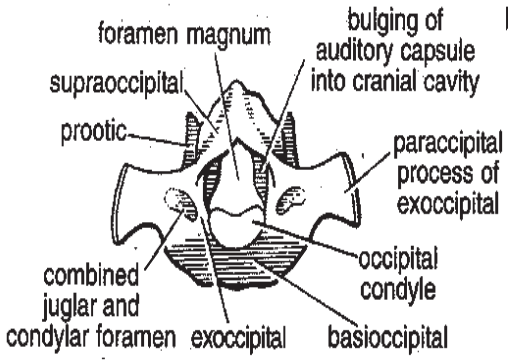


Fig. 4.2 Occipital segment (Posterior view)

(b) Parietals regions:

(i) Parietal

1. Parietals forms the roof of the cranium.

2. Two parietals are fused together to form a single bone.

3. It is broad in front and narrow from behind.

4. It has a parietal foramen in its centre.

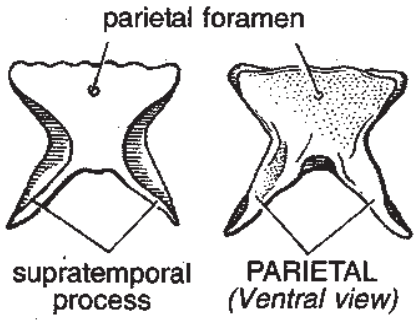


Fig. 4.3 Parietal (Dorsal view)

(ii) Basisphenoid

1. They form the floor of the cranium.
2. These are broad, flat and somewhat rectangular.
3. It has a pair of basipterygoid processes on its antero-lateral side.

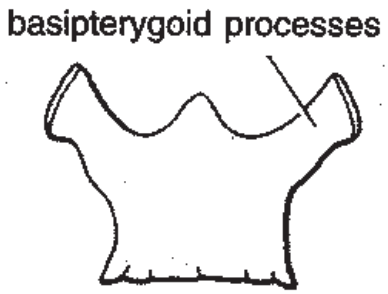
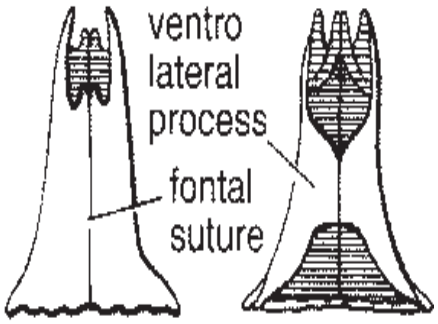


Fig. 4.4 Basiphenoid (Ventral view)

(c) Frontals region:

(i) Frontals

1. Fronts forms the roof of the frontal region of the cranium.
2. These bone are formed by the fusion of two frontal bones through mid-line.
3. Frontal muscle are narrow in front and broad behind.
4. These frontals posteriorly join with the parietals by a coronal structure.



(A) Dorsal view (B) Ventral view

Fig. 4.5 Frontals

(ii) Parasphenoid

It is a large rod like bone present in front of basisphenoid.

(d) Sense Capsule(Olfactory Capsule)

- **Nasals**

1. Nasals form the roof of olfactory capsule.

2.Two nasals bones are fused into a one compound bone through mid line.

3. Each nasal bone is flat and triangular anteriorly and broader from behind.

Fig. 4.6 Nasals (Dorsal view)

- **Vomer**

1. Vomer are the bone of olfactory capsule lies on its floor.

2. It is rod shaped uniting with its counterpart in its mid line .

3. It makes inner margin of the posterior nare and is perforated by a vomerine aperture in its centre.

Fig. 4.7 Vomer (Ventral view)

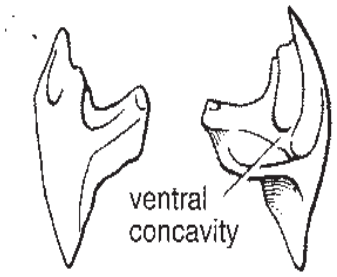
- **Prefrontal**

1. They are found in the bone of orbital capsule.

2. It is a small, more or less triangular bone bearing a deep cup like concavity on its ventral side.

3. It lies obliquely between the frontal and maxilla.

4. It forms the anterior boundary of orbit.



(Outer view) (Inner view)

Fig. 4.8 Prefrontal

- **Postorbital or postfrontal**

1. They are found in orbital capsule.

2. It is an irregular bone producing four processes.

3. A deep notch is present in between two inner processes.

4. Squamosal articulates with posterior longest process where as antero lateral remains free.

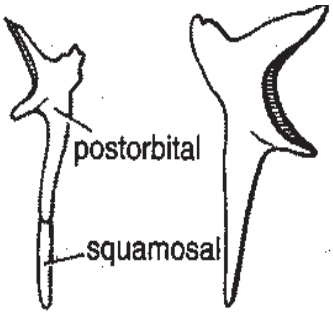


Fig. 4.9 Postorbital and Squamosal

- **Supraorbital**
    1. They are found in orbital capsule.
    2. These bones are triangular in shape.
    3. Broad base articulates in front with the prefrontal, while its free apex is directed posteriorly towards post –orbitals.

Fig. 4.10 Supraorbital

- **Lacrymal**
    1. small square shaped bone.
    2. lying within orbit.
    3. It contain a aperture for lachrymal duct and it articulates to maxilla.

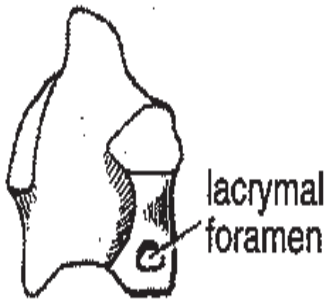


Fig. 4.11 Lacrymal

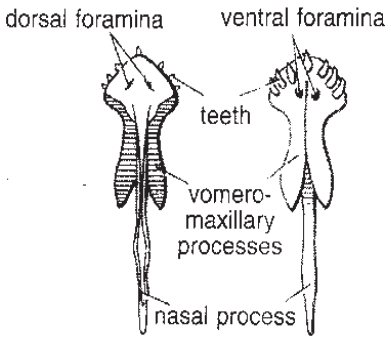
(e) Suspensorium: They suspend lower jaw from cranium. It includes quadrates and squamosals

1. These are small rod like bone found in suspensorium.
2. These bone lies obliquely in the postero-lateral side of the hind region of cranium.
3. It articulates with squamosal at the posterior.

(f)Bone of Upper Jaw:

a) Premaxillae

1. Two premaxillae are fused into a single bone through mid-line .
2. They form the anterior part of snout.



(Dorsal view) (Ventral view

Fig. 4.12 Premaxillae

b) Maxilla

1. They form the bulk of upper jaw.
2. Theses muscles is long, irregular bone lying on either side behind the premaxilla.
3. Outer surface is covered by maxillary foramina.
4. Body is known as alveolar.
5. Alveolar part bears a row of 8 -10 teeth along its ventral margin.
6. Teeth are small, conical and pleurodont.

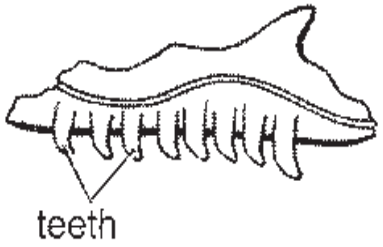


Fig. 4.13 Maxilla

c) Palatine:

1. These bone forms the roof of buccal cavity.
2. These bone are small, flat ,irregular in shape.
3. These muscles also forms the posterior boundary of the internal nare.

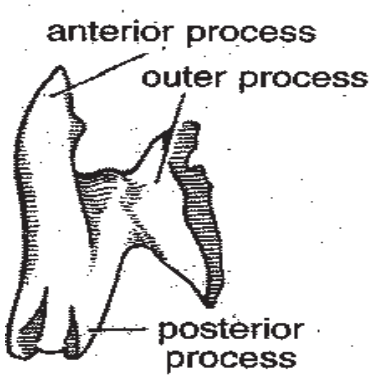
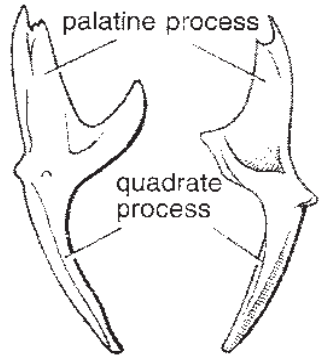


Fig. 4.14 Palatine

d)Pterygoid

1. These are large elongated and irregular bone.
2. It comprises of anterior palatine process and a posterior quadrate process.



(Ventral view) (Dorsal view)

Fig. 4.15 Pterygoid

(g) Lower Jaw (Mandible): it comprises of 5 parts

a) Articular:

1. It is posteriormost bone of the lower jaw ramus.
2. it covers behind angular process.

b) Angular:

1. It is small splint-like bone located between dentary and articular.
2. Perforated by angular foramen.

c) Supra-angular:

1. It is located in middle of each ramus.

2. elongated, nearly rectangular bone.

d) Coronoid:

1. It is a small process which form dorsal side of middle ramus.

e) Splenial:

1. It is a membranous bone.

2. It is found on inner side of dentary.

f) Dentary:

1. It is largest long bone.

2. Its anterior end is blunt.

3. It bears 8-10 small teeth (Pleurodont) arranged in a row

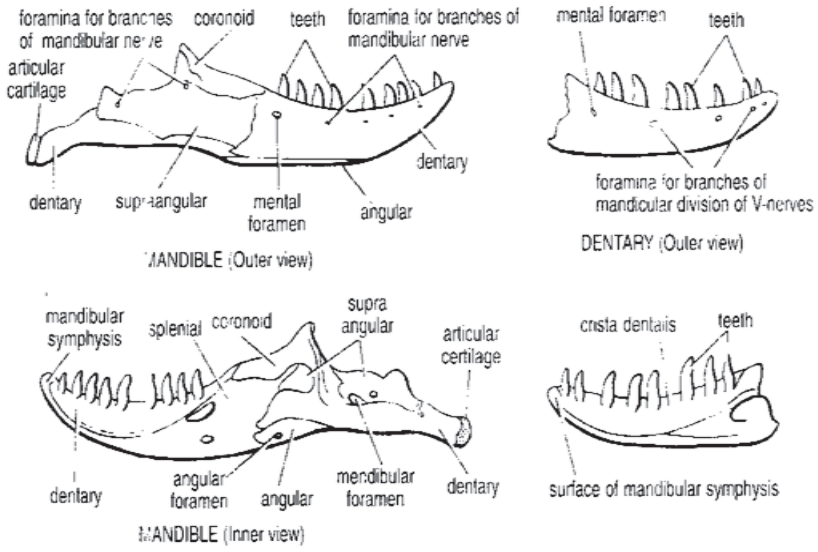


Fig. 4.16 Lower jaw of Varanus

(B)Vertebral Column

a)Atlas vertebra

1. Atlas vertebra is the first vertebra of cervical region.

2. It is small and ring like in shape.

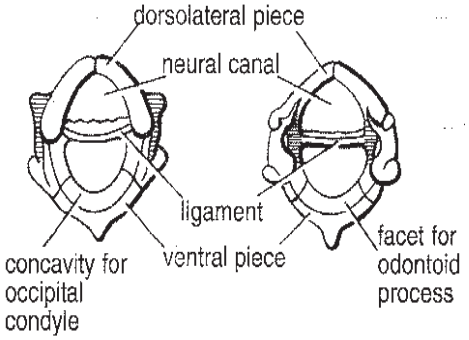
3. It has no distinct centrum.

4. It comprises of 3 distinct bony pieces.

5. Neural canal is divided by ligament into dorsal and ventral portion.

6. Pre-and post zygapophysis are absent.

7. Transverse process are absent.



(Anterior view) *(Posterior view)*

Fig. 4.17 Atlas

b) Axis vertebra

1. Axis vertebra is the second vertebra of cervical region.

2. It is slightly larger than typical cervical vertebra but quite similar in structure.

3. It has odontoid process at the anterior face of centrum.

4. Neural spine is vertical and crest like.

5. At the ventral surface of the centrum hypapophysis is present.

6. Pre-and post zygapophysis are absent.

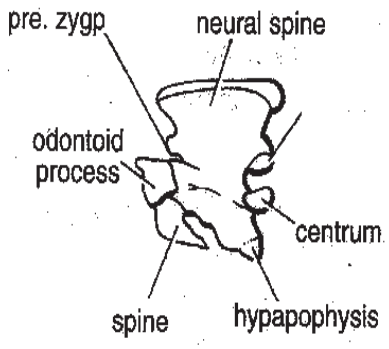


Fig. 4.18 Axis

c) Typical cervical vertebra

1. Centrum is short and procoelous.

2.Neural spine is vertical and crest like.

3. Prezygapophysis are directed upwards and outwards.

4. Postzygapophysis are directed downwards and inwards.

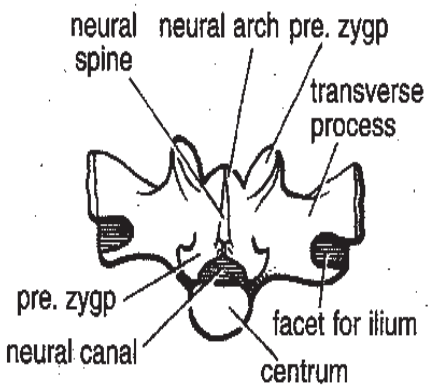
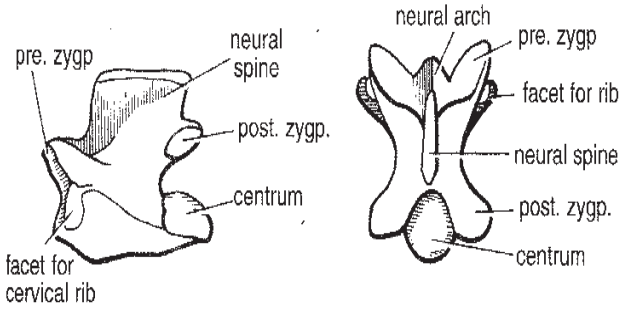


Fig. 4.19 Typical cervical

d) Thoraco-lumber:

1. Found at the junction of neural arch and centrum.
2. Well developed pre and post zygapophysis.



(Lateral view) *(Dorsal view)*

Fig. 4.20 Thoraco-lumber

e) First sacral:

1. It supports pelvic girdle.
2. Well developed pre and post zygapophysis

f) Second sacral:

1. Well developed pre and post zygapophysis
2. Notch is absent.

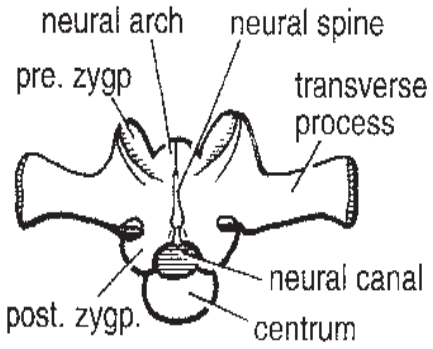
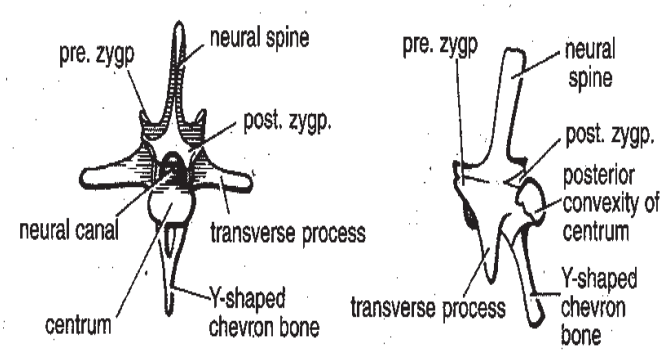


Fig. 4.21 Second sacral

g) Anterior caudal:

1. It is like sacral superficially but it contains a long centrum, slender neural spin and transverse process.

2. Fairly developed pre and post zygapophysis.



(Posterior view) *(Lateral view)*

Fig. 4.22 Caudal

(C)Sternum:

1. A rhomboidal plate of calcified cartilage embedded in thoracic region.

2. Anteriorly articulated with coracoids and epicoracoids of pectoral girdle & posteriorly articulation with sternal ribs.

3. Its posterior end bears two sternal ribs.

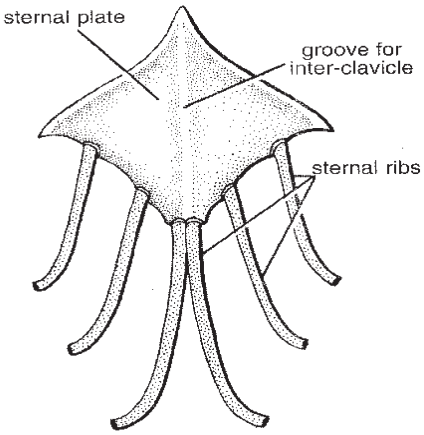
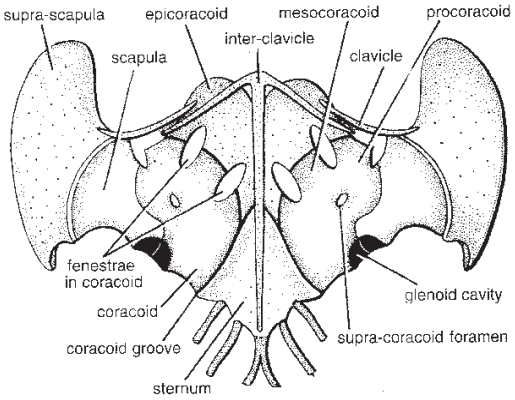


Fig. 4.23 Sternum of Varanus

(D) Appendicular Skeleton:

a) Pectoral Girdle

1. Pectoral Girdle is made up of two halves attached with T shaped interclavicle.
2. Each Half is made up of suprascapula, scapula, coracoid, interclavicle and clavicle.
3. Suprascapula is flattened, calcified cartilaginous plate, articulating with scapula.
4. scapula is completely ossified, flattened plate articulating with suprascapula and coracoid.
5. Coracoid is a flat bone partly ossified and partly cartilaginous.
6. Interclavicle are T shaped bone.
7. Clavicle are short, curved dermal bone articulating with suprascapula and interclavicle.



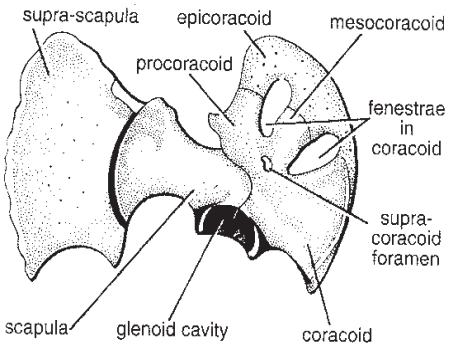


Fig. 4.24 Pectoral Girdle *Fig. 4.25 One- half of Pectoral girdle*

b) Pelvic Girdle:

1. It has three bones namely ilium, pubis and ischium.
2. Ilium is a rod shaped bone constituting major part of acetabulum.
3. Pubis is a curved bone. They constitute one-third of acetabulum.
4. Ischium is flat and slightly curved & it articulates with pubis and ilium of its side.

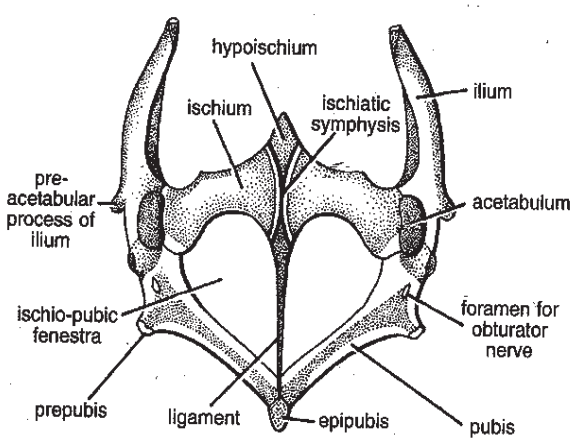


Fig. 4.26 Pelvic girdle

(D) Limb Bones:

a) Fore Limb

(i) Humerus: Humerus is upper arm, single bone with both ends expande, its proximal end contains head which fits into glenoid cavity.

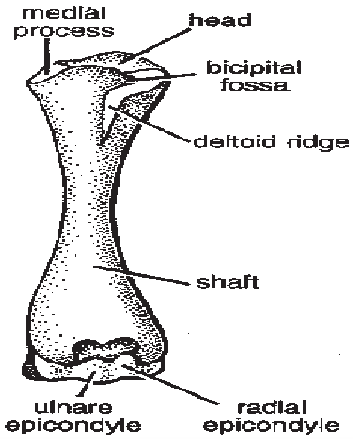


Fig. 4.27Humerus

(ii) Radius and ulna: It is slender & made up of a shaft and two epiphysis. Ulna is stouter

(iii) Hand bones: Wrist is made up of 10 small polyhedral rounded bony carpals arranged in two rows.

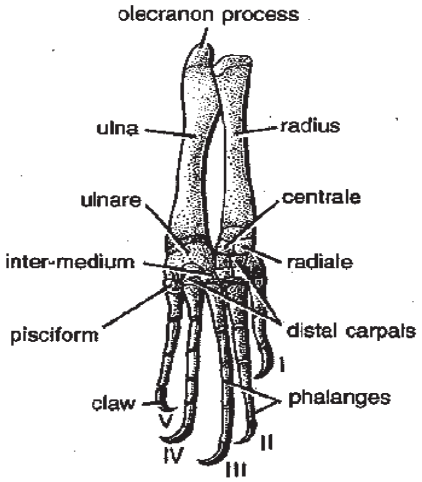


Fig. 4.28 Radius, Ulna and bones of hand

b) Hind Limb

1. Hind Limb is made up of femur, tibia, fibula and bones of hind-foot.

2. Femur is thigh bone having two epiphyses. Proximal end contains head which fits into acetabulum while distal end is pulley-shaped.

3. Tibia and fibula are shank bones. Tibia is stout, curved while fibula is slender.

4. Bones of hind-foot is made up of 5 tarsal bones. I, II, III, IV and V toes contains 2, 3 ,4,5 and 3 phalanges. respectively.

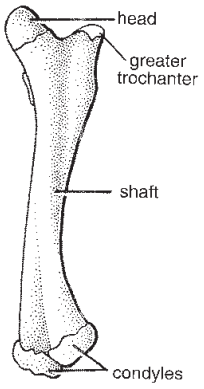


Fig. 4.29 Femur

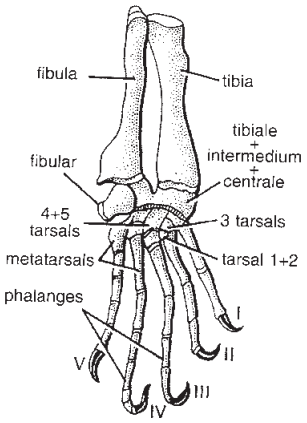


Fig. 4.30 Tibia and Fibula & bones of foot

4.6 STUDY OF MUSEUM SPECIMENS

1. *Varanus*

General Characteristics:

1. *Varanus* is commonly known as Indian monitor lizard.
2. They grows to a length of 60-90 cmand are of brownish color.
3. Body is covered with very small and smooth scales and tubercles.
4. Ventral scales are arranged in transverse rows.
5. Head is flattened and neck is long.
6. Tail is very long and laterally compressed and storehouse for fat.
7. Limbs are well developed and adapted for swift movement, digits are clawed.
8. Tongue is smooth, long, slender, bifid and protrusible, retractile into a sheath. Teeth are pleurodont.
9. They are carnivorous.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Varanus*

Species : *monitor*

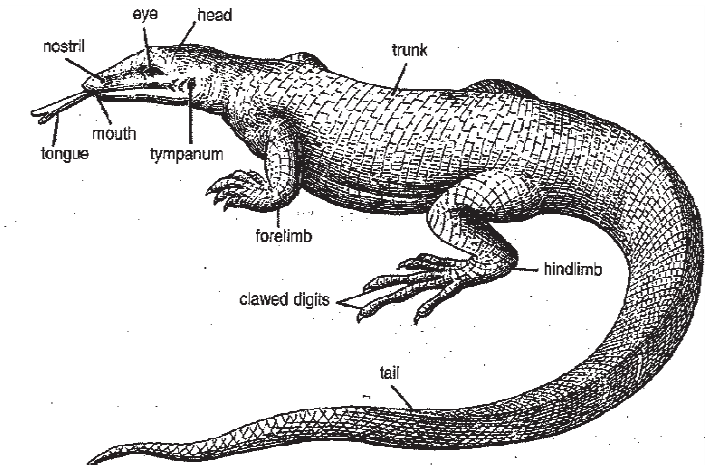


Fig. 4.31Varanus monitor

2. *Heloderma suspectum*:

General Characteristics:

1. *Heloderma* is commonly known as gila-monster or beaded lizard.
2. It is a poisonous lizard.
3. Body measuring about 60 cm, is covered with many irregular tubercles.
4. They are of blackish brown color forming coloured patches.
5. Limbs are short but strong well developed and capable for swift movement.
6. Tail is short but thick and adapted for fat reserve.
7. Tongue is smooth, protrusible and bifid in front.
8. Teeth are pleurodont, fang –like, contain labial poison glands curved with slightly swollen base.
9. They are carnivorous feeding on worms, centipedes, frog.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Heloderma*

Species : *suspectum*

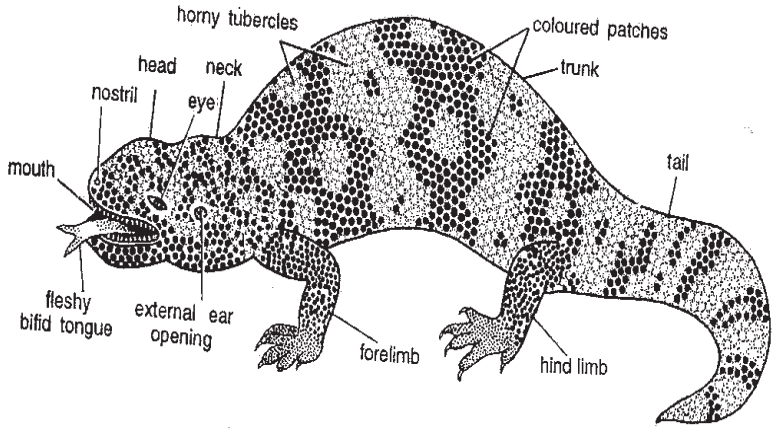


Fig. 4.32Heloderma suspectum

3. *Hemidactylus:*

General Characteristics:

1. *Hemidactylus* are commonly known as wall lizard or house lizard.
2. They are about 25 cm in length and pale green in color.
3. Body is covered by scaly integument. Scales are minute and smooth.
4. Head is broad and flat.
5. Eye lids are fused over the eyes.
6. Ear opening is vertical.
7. Tongue is short, sticky.
8. Digits are clawed and dilated with two rows of ridged lamellae on the lower surface for the movement on ceilings and smooth surface.
9. Tail possess the regeneration capability.
10. Only one supra temporal arch is present.
11. Parietal organ is present.
12. They are amphicoelous.
13. They feeds on insects

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont,

vertebraeprocoelous, cloacal opening transverse.

Genus : *Hemidactylus*

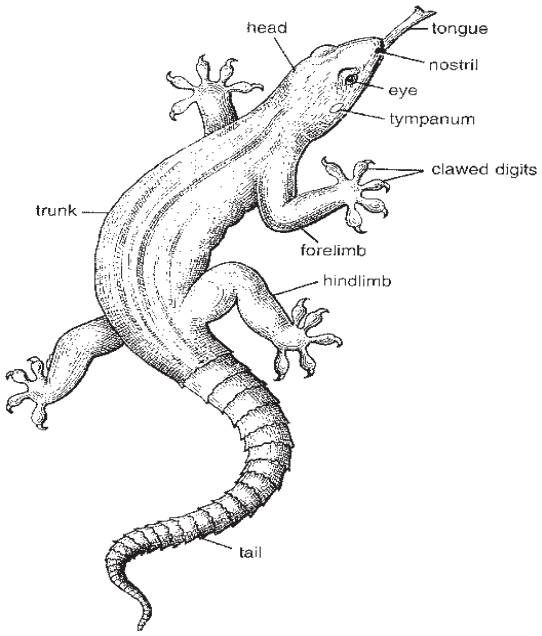


Fig. 4.33Hemidactylus

4. *Phrynosoma* (Horned toad):

General characteristics:

1. They grows to a length of 12 cm.
2. Body is flattened and broadened and covered with larger and smaller strongly keeled scales.
3. Dorsal crest is absent.
4. Under parts are covered with small very regular keeled scales.
5. Head contain five spikes on each side, 1 post –orbital, 3 temporal and 1 occipital. It also contain eyes, nostrils and prominent helmet.
6. Sides of lower jaw project in the shape of prominent ledges and are protected by a series of small spines.
7. They have a long row of pores in both sexes on the under surface of the thighs.
8. Tongue is fleshy and non-protrusible. Teeth are pleurodont or homodont.

Identifying characteristics:

Animal contains rough skin, spines all over the body.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Phrynosoma*

Species : *cornutum*

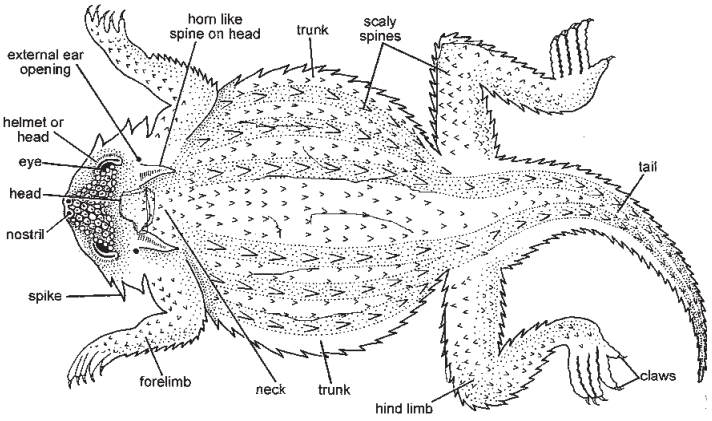


Fig. 4.34*Phrynosoma*

5. *Chamaeleon*

General Characteristics:

1. *Chamaeleon* is an arboreal lizard.
2. Skin is covered with minute's tubercles or granules.
3. Body and head are laterally compressed.
4. Head is usually forming casque with prominent crests and tubercles.
5. Eyes are large and covered with glandular lid, eyes are adapted for binocular vision.
6. Tympanum and tympanic cavity are absent.
7. Tongue is spoon shaped extremely protrusible and covered with a sticky secretion.
8. Limbs are relatively large and very slender.
9. Tail is long and prehensile.
10. Teeth are acrodont.
11. It has power of changing color.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Chamaeleon*

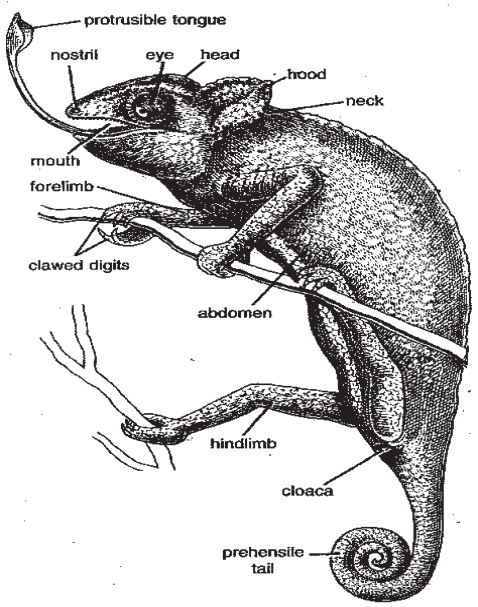


Fig. 4.35 Chamaeleon

6. Draco(Flying dragon or flying lizard):

General characteristics:

1. Body is dorso ventrally compressed and measuring about 20- 25 cm in length.
2. Tail comprises near half of its total length.
3. Teeths are heterodont.
4. On both side of the body between the fore and hind limbs wing patagium formed by extension of skin is present, which are supported by lateral ribs.
5. Three pointed hooks are present on the throat.
6. Male has a small nuchal crest.
7. Distensible gular pouch is present in both sexes but larger in male.
8. They use their patagia as parachutes.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Draco*

Species : *volans*

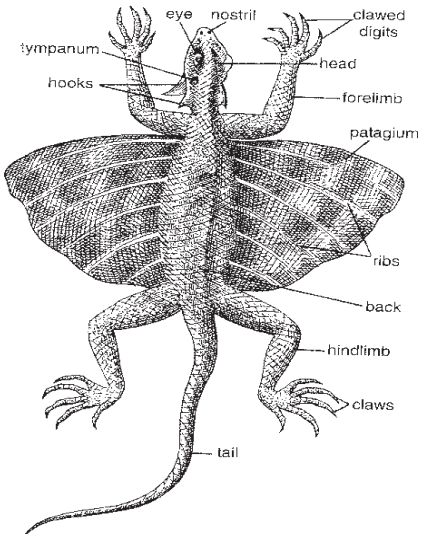


Fig. 4.36 Draco

7.Calotes:

General Characteristics:

1. *Calotes* are commonly knowns as garden lizard or girgit.
2. They are found in open fields and hedges.
3. The body is long about 30 cm in length and covered with tough /horny scales.
4. Crest of sharp spines is present on the dorsal surface of the neck.
5. Body is easily divisible into head, trunk and tail.
6. Mouth is anteriorly placed on the head.
7. Cloacal opening is transverse situated on the ventral surface at the root of the tail.
8. Tail is extremely long and cylindrical .
9. They shows a remarkable characteristics of changing colors .
10. They feeds on insects.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Calotes*

Species :*versicolor*

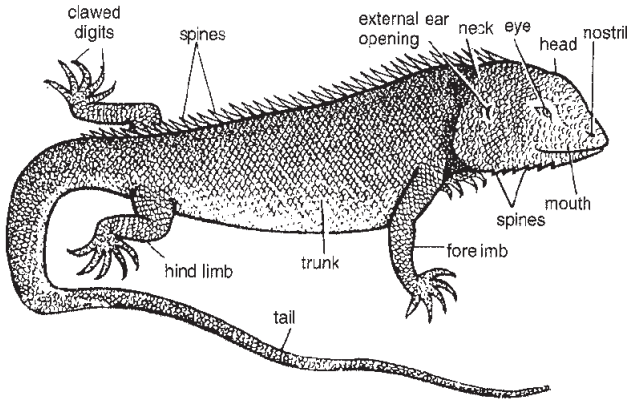


Fig. 4.37Calotes

8.*Naja*(Cobra):

General Characteristics:

1. *Najanaja* is commonly Known as Indian Cobra or nag.
2. They are poisonous snake. Their venom is neurotoxic. Poison fangs are followed by 1-3 small teeth.
3. Body is elongated measuring 2 m to 3 m in length and brown or blackish in color.
4. Body is covered with smooth oblique scales without pits and are arranged in 15 -25 rows.
5. Upper surface of the hood bears a binocoellate mark.
6. Lower surface of the hood bears two dark round spots running to 4 scales surrounded by white lateral borders.
7. Nostrils lies between two nasals and inter-nasal.
8. Tail is cylindrical and tapering posteriorly.
9. Oviparous.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : Naja

Species : naja

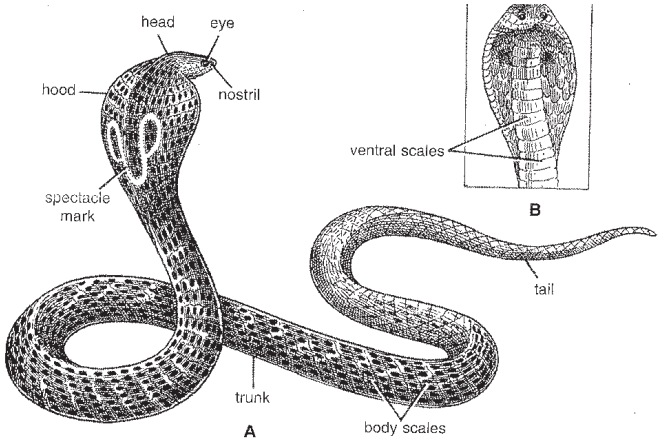


Fig. 4.38*Naja naja*

9. *Ancistrodon* (Pit-viper)

General characteristics:

1. *Ancistrodon* are commonly known as Himalayan Pit-viper.
2. They are poisonous snake. Their venom is haemotoxic.
3. Body length is of about 70cm- 1 m.
4. General color is bluish-brown with dark brown or black spots appearing like cross bars.

5. Head is triangular containing nostrils, eyes and mouth. A characteristic lorealpitis present on each side of upper jaw separating eye & nostril. Mouth is grey with black spots.
6. Upper lip is slightly raised in rostral region.
7. Eyes are big with golden iris and vertical pupil.
8. Loreal-pits is present in between the eyes and nostril on each side.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Ancistrodon*

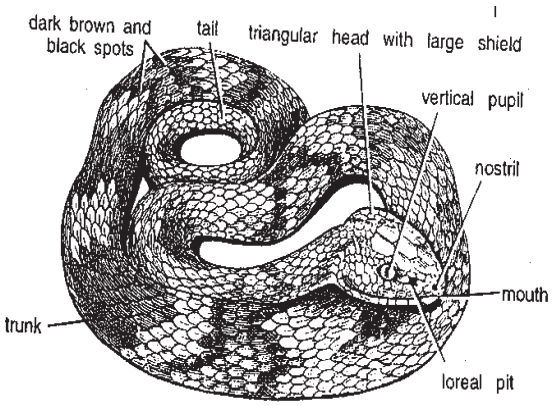


Fig. 4.39Ancistrodon

10.*Crotalus*(Rattle snake)

General Characteristics:

1. *Crotalus* are commonly as rattle snake.
2. They are poisonous snake. Their venom is hemotoxic.
3. They are of grey-brown color with dark bands on the body forming a pattern.
4. Body is elegantly elongated reaching a length of about 2-3metres.
5. Head is distinct from neck, upper surface of the head is covered with small scales.
6. There are two erectile fangs in front of jaw, one on each maxillary bone and folded backwards when not in use.
7. It is the presence of rattle at the end of tail from which it name has been derived.
8. Rattle is formed by the union of 10-12 hollow segments of dry horny skin.
9. Rattle causes a noise which is useful as a warning tools.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Crotalus*

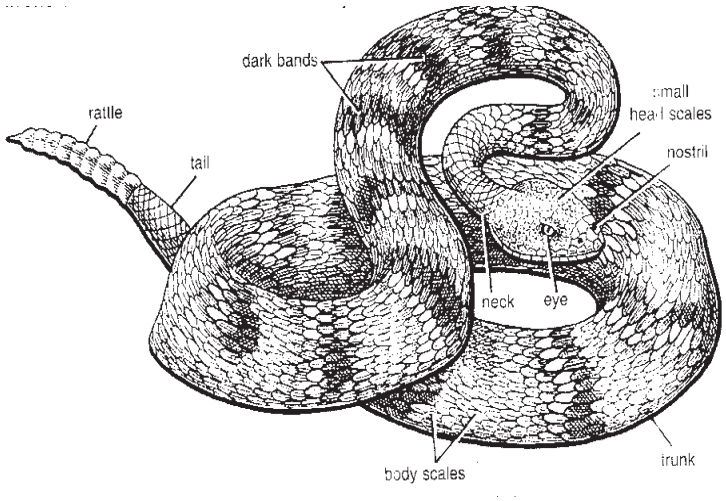


Fig. 4.40Crotalus

11. *Bungarus*(Krait)

General Characteristics:

1. *Bungarus* is commonly known as krait.
2. They are poisonous snake. Their venom is neurotoxic.
3. Body is elongated and cylindrical growing upto 1 m length.

4. Color is steel blue with narrow cross bars or white specks dorsally and underparts are uniform white.
5. Head is not differentiated from neck and contains eyes, nostrils, bifid and protrusible tongue.
6. Loreals are absent. Post ocular, preocular and supra-labial 2, 1 and 7 in number respectively.
7. Eyes are of moderate size with narrow& roundpuplis.
8. Scales are smooth and form 13 -17 rows. Ventrals are 194-234 and 42-52 caudals.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Bungarus*

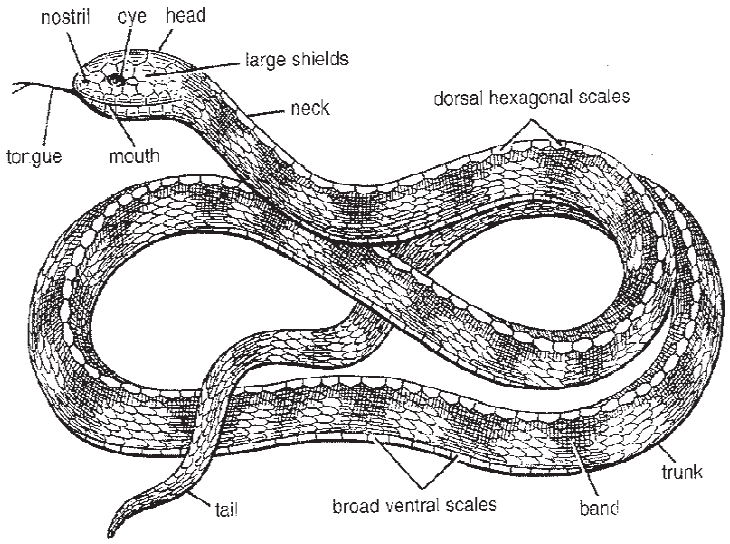


Fig. 4.41Bungarus

12. *Zamenis* (Dhaman):

General Characteristics:

1. *Zamenis* is commonly known as dhaman or rat-snake of India. It attacks forcibly like a whip and hence it is called as rope snake.
2. They are non-poisonous snake.
3. It grows to a length of 2 mts or more.
4. Their body color is brown with black cross bands on the posterior part of the body and tail and underparts are yellow in color.
5. Body is covered with 16-17 rows of slightly keeled scales..
6. Presence of prominent dorsal ridge of the back bone along the mid dorsal line.
7. Eyes are large with round pupil.
8. Tail is long and prehensile.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

.Genus : *Zamenis*

Species :*mucosus*

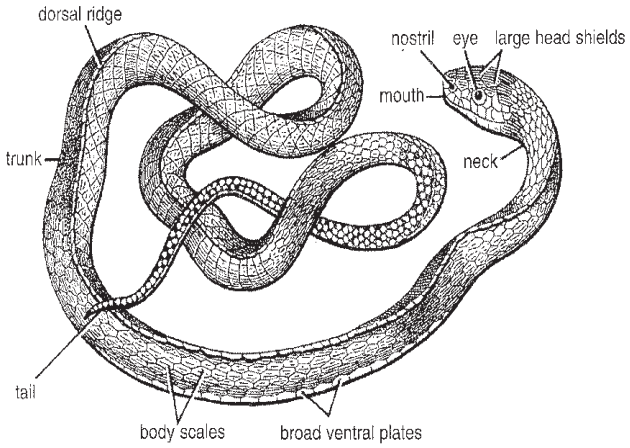


Fig. 4.42Zamenis

13.*Typhlops*:

General Characteristics:

1. *Typhlops*is commonlyknows as blind snake.
2. They are about 175-180 mm in length and look like earthworm and is of dark chocolate color.

3. Body is cylindrical and covered by thin overlapping cycloid scales in multiple rows over whole body.
4. Head is not distinct from the body.
5. Tail is blunt.
6. Eyes are small and more or less covered by scales.
7. Few teeth are present in upper jaw only. Lower jaw toothless.
8. Presence of large rostral, nasal , ocular and preocular shield.
9. Sebaceous glands are present on the body.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton
Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.
Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.
Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.
Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.
Genus : *Typhlops*

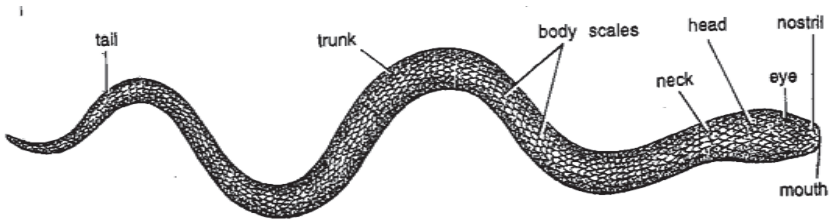


Fig. 4.43Typhlops

14.*Hydrophis*(marine snake)

General Characters:

1. *Hydrophis* is commonly known as sea-snake.
2. They are deadly poisonous snake. Their venom is neurotoxic.
3. Body is long and laterally compressed and covered with small scales.
4. Head and neck are very slender.
5. They are of dark olive green color with yellowish cross bars above and white below.
6. Tail is laterally compressed and acts like paddle in swimming.
7. Eye are small with rounded pupil.
8. Loreal shield is absent.
9. There are 1 pre-ocular, 2 post –oculars and 7-8 supra labials.
10. 14-18 maxillary teeth behind the poison fangs.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and

squamosal usually meet between temporal vacuities.

Super order : Lepidosauria --- Two temporal vacuities present, anterior orbital vacuities absent, humerus with two foramina.

Order : Squamata --- body covered with horny epidermal scale, teeth pleurodont, vertebraeprocoelous, cloacal opening transverse.

Genus : *Hydrophis*

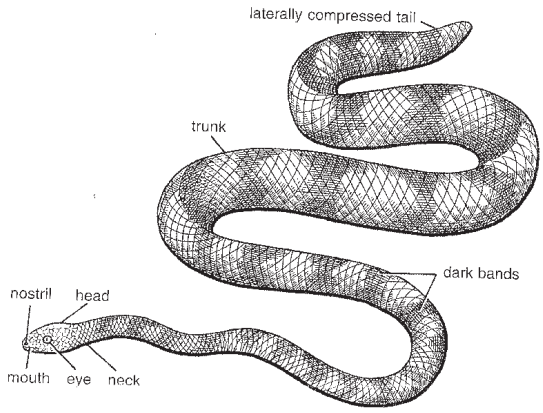


Fig. 4.44Hydrophis

15.*Alligator*

General Characters:

1. Body is covered with an exoskeleton of horny epidermal scales.
2. Body color is greenish-black or dark brown above and yellowish below.
3. Length varies from 2.5metres to 4metres.
4. Head is broad with short, broad and rounded snout.
5. Limbs pentadactyle with five fingers and four toes with webs.
6. Tail islong & laterally compressed.
7. There is 17-20/17-22 teeth on each side.
8. Nasal bones divide the nasal groove by a median bony septum.
9. Dorsal shield is formed by 6 or 8 longitudinal series of keeled bony scutes.
10. Neck is protected by two pairs of large scutes.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida ---Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Archosauria --- Skull with closed upper temporalvacuity, but possesses both Temporal arches, teeths are thecodont.

Order : Crocodilia --- body covered with thick horney epidermal scales, tail long laterally compressed.

Genus : *Alligator*

Species : *mississipiensis*

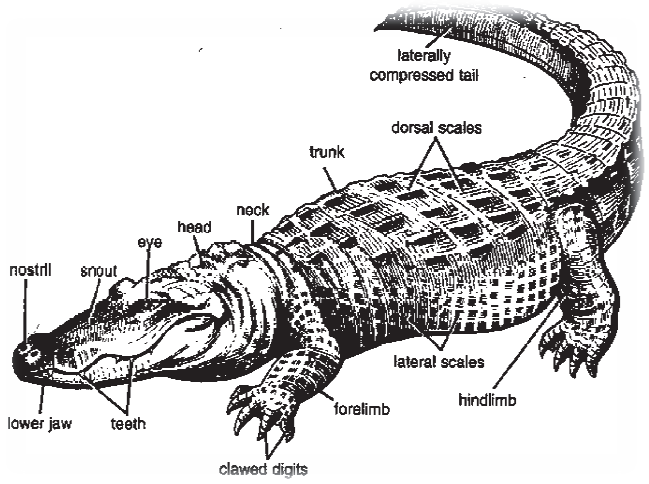


Fig. 4.45Alligator

16. *Crocodile*

General Characteristics:

1. *Crocodilus* is commonly known as muggar of India or marsh-crocodile.
2. Body is covered with an exoskeleton of horny thick epidermal scales provided with dermal bony plates.
3. Upper parts of body is dark olive-brown with black bands or spots.
4. Length vary from 4- 6 metres.
5. Head is triangular and narrow towards snout.
6. Limbs are pentadactyle with five finger and four toes ending in claws and with webs.
7. Tail is long and laterally compressed.
8. Dental formula is 16-19/14-15.
9. Heart 4 chambered with separate ventricles.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Archosauria --- Skull with closed upper temporalvacuity, but possesses both Temporal arches, teeths are thecodont.

Order : Crocodilia --- body covered with thick horney epidermal scales, tail long laterally compressed.

Genus : *Crocodylus*

Species : *porosus*

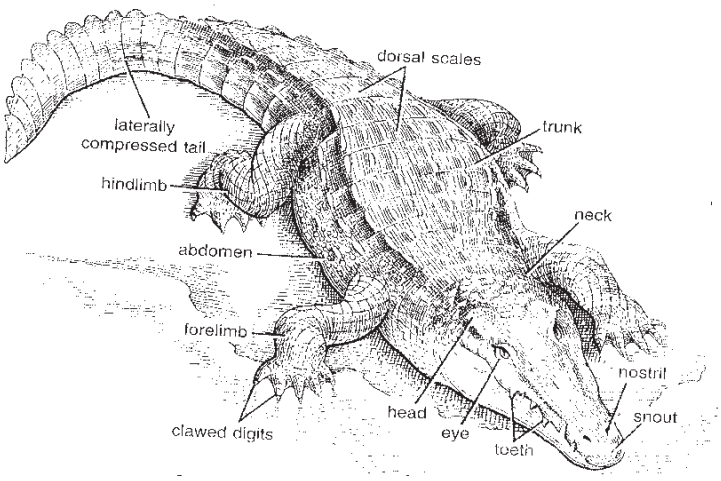


Fig. 4.46Crocodile

17.*Gavialis* (Ghariyal)

General Characteristics:

1. They attain a length of about 5-6.5 metres.
2. Body color is dark olive-brown with dark marking.
3. Body is covered with an exoskeleton of bony and epidermal horny scales.
4. Snout is extremely long and slender.
5. Limbs are pentadactyle with five finger and four toes end ending in clawed.
6. Tail is laterally compressed, strong and elongated.
7. There are 28 teeth in upper jaw and 25 teeth in lower jaw on either side.
8. Nasal bones are very short and are seprated from premaxillaries.
9. In male the nose is very much swollen which is inflated like a beak when nostrils are closed.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Diapsida --- Two temporal vacuities on each side, post orbital and squamosal usually meet between temporal vacuities.

Super order : Archosauria --- Skull with closed upper temporalvacuity, but possesses both Temporal arches, teeths are thecodont.

Order : Crocodilia --- body covered with thick horney epidermal scales, tail long laterally compressed.

Genus : *Gavialis*

Species : *gangeticus*

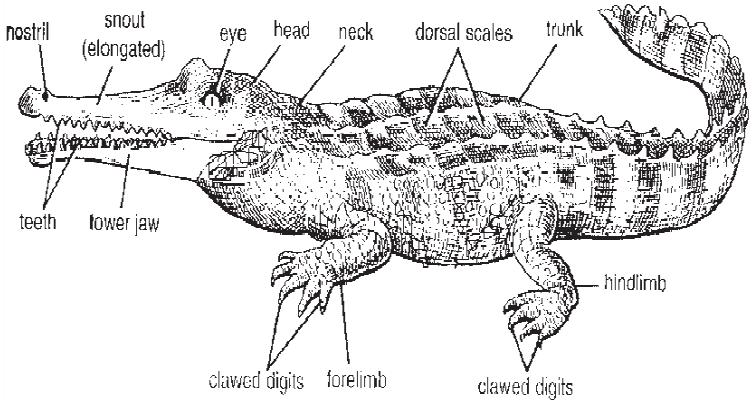


Fig. 4.47Gavialis

18.*Turtle*

General Characteristics:

1. *Chelone* is commonly known as Green Turtle.
2. Body is of olive or brown in color varying from 85 – 110 cm in length.
3. Body is enclosed in a shell .
4. Carapace is flat covered with smooth bony shields.
5. Dorsal shields are juxtaposed, fitting closely with each other.

6. Head is covered with one pair of prefrontal shields. Head bears two eyes having eyelids and nictitating membrane.
7. Fore and hind limbs form wing like paddle.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group : Craniata --- cranium with brain present
Sub-Phylum : Vertebrata --- vertebral column present
Division : Gnathostomata--- Jaws and paired appendages are present
Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton
Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.
Sub class : Anapsida --- Primitive reptiles, body enclosed in the carapace and Plastron.
Order : Chelonia --- Jaws without teeth but with horney sheaths
Genus : *Chelone*
Species : *mydas*

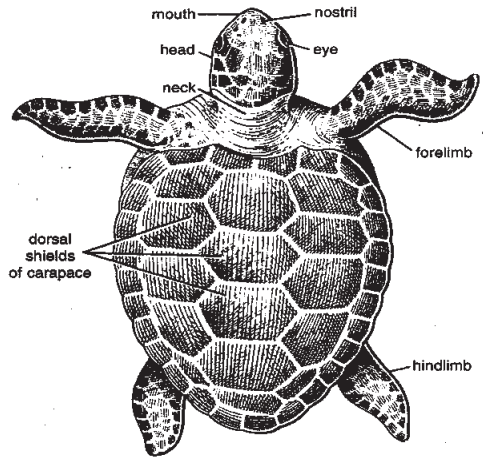


Fig. 4.48Chelone mydas

19.Tortoise

General Characteristics:

1. *Testudo* is commonly known as land- tortoise or giant turtle .
2. Males being smaller than females.
3. Body is enclosed with a shell. Body shell is oval with an outer leathery skin or cornified scutes.
4. Dorsal convex portion or carapace and the flatter ventral portion or plastron are joined on sides by skin.
5. Head contains eyes, nostrils and mouth and ear opening behind the eyes.
6. Jaws lacks teeth but have stout cornified sheath to crushing the food.

Systematic Position:

Phylum : Chordata --- Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata --- cranium with brain present

Sub-Phylum : Vertebrata --- vertebral column present

Division : Gnathostomata--- Jaws and paired appendages are present

Superclass : Tetrapoda --- Paired limbs, lungs, and bony skeleton

Class : Reptillia --- Cold Blooded, Terrestrial or aquatic vertebrates, respiration by lungs; heart with two auricles and incompletely divided ventricles, embryo with amnion and allantois.

Sub class : Anapsida --- Primitive reptiles, body enclosed in the carapace and Plastron.

Order : Chelonia --- Jaws without teeth but with horney sheaths

Genus : *Testudo*

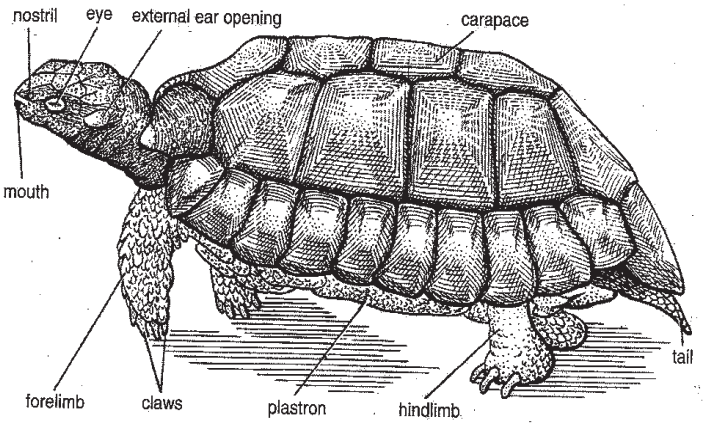


Fig. 4.49Testudo

4.7 SUMMARY

Class Reptilia (L., reptum "Crawl" or repere) includes vertebrate animals such as lizards, snakes, turtle, crocodile etc have dry skin covered by ectodermal horny scales. They are cold blooded, bony skeleton, repiration by lung, 3 chamber heart except crocodile. There are nearly 7,000 species inhabiting the earth.

Reptilia can be segregated into five subclasses: Anapsida, Euryapsida, Parapsida, Diapsida and Synapsida. These classes are distinguished by on the basis of presence or absence of temporal vacuities in skull.

Sub Class Anapsida have no temporal vacuities. Members of class Euryapsida have a single pair of temporal vacuities. Parapsida have one pairs of temporal vacuities on either side. Dipsida have two temporal vacuities on each side of skull.

Reptiles plays an important role in human's social, religious life. They have been associated as gods or as signs of gods in several folklore, religion. They plays an important role in agriculture by controlling the populations of several rodents and insects, and in medicine development. In some country they are consumed as foods. Alligators, Crocodile and Snake skin is used in making shoes, belts and bags.

4.8 GLOSSARY

Acrodont:formation of teeth where teeth are consolidated with the summit of the alveolar ridge of the jaw without sockets.

Amniote: This is a group of tetrapods (four-limbed animals with backbones or spinal columns) that have terrestrially adapted eggs, including amphibians, reptiles, birds, and mammals.

Amphicoelous:a structure that is concave at both ends.

Arboreal: Lives in trees or bushes.

Carapace: A bony or hard shell that covers part or all of an animal.

Casque: The head or crest of an animal

Cloaca: A chamber that opens through the anus that is used for both excretion and reproduction.

Cranial: Often referring to the top of the head.

Dorsal: Pertains to the back or upper surface.

Ectothermic: An animal that cannot regulate its own body temperature, rather it's regulated by the environment, so they often bask for heat, burrow, and hibernate.

Hemotoxic: A poison that effect circulatory system.

Jacobson's organ: An organ for detecting odor located in the roof of the mouth. The tongue delivers the odor. The nostrils connect to the lung or lungs.

Keel: A ridge on a scale.

Lateral: Pertaining to the side.

Monocondylic: skull which contains single occipital condyle.

Neotenic: Reaching sexual maturity while still in larval form; some salamanders.

Neurotoxin: A poison that affects the nervous system.

Plastron: The lower shell of a turtle.

Posterior: Pertaining to the rear.

Prehensile tail: Capable of grasping or wrapping with the tail.

Rostral: Horns around the nose area.

Scute: A horny, chitinous, or bony external plate or scale, as on the shell of a turtle or the underside of a snake.

Tarsal Spur: A spur found on the back of the rear feet on male Veiled chameleons for use in breeding.

Terrestrial: Lives on the land.

Thorax: A division of an animal's body that lies between the head and the abdomen.

Toxin: A poisonous substance.

Tympanum: The external eardrum.

Venom: A toxin produced by an animal.

Ventral: Pertaining to the underside, the lower surface.

4.9 SELFASSESMENT QUESTION

1. Skin of reptiles is covered by

a) Scales b) Horny plates c)Horny scutes d) All

2. First true terrestrial vertebrates are :

a) Amphibians b) Mammals c) Reptiles d) Birds.

3. Snakes lacks

a) Girdles b) limbs c) urinary bladder d) All

4. Reptiles are found everywhere except:

a) Greenlands b) Siberia c) New Zealand d) Antarctica.

5. Which of the following can change its color

a)Chameleon b)Draco c) Heloderma d) Hemidactylus

6. Which one of the following lizard is poisonous

a) Draco b) Heloderma c) Varanus d) Hemidactylus

7. Flying lizard is

a)Phrynosoma b)Varanus c) Draco d) Typhlops

8. If tail is flat, snake will be

a) Land based b) Water based c) Both d) None

9. Only reptile having 4 chambered heart is

a) Crocodile b) Tortoise c) Phrynosoma d) Gavialis.

10. Poison glands of snakes are modified :

a) Maxillary teeth b) Submaxillary glands c) lingual glands d) Parotid gland

11. Poison of which snake is haemotoxic

a)Cobra b) Pit –Viper c) Bungarus d) Hydrophis

12. Poison of which snake is neurotoxic

a)Cobra b) Elaps c)Pit –Viper d) Crotalus

Answer:

1(d) 2(c) 3(d) 4(d) 5(a) 6(b) 7(c) 8(b) 9(a) 10(d) 11(b) 12 (a)

4.10 REFERENCES

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- **Lal, S. S. (2015)**: Practical Zoology Vertebrate .Rastogi Publications. Merrut.
- **Pandey, B**.N. (2015): Animal diversity volume 1, Tata McGraw Hill Education Private Limited.

4.11 SUGGESTED READING

- Cleveland Hickman, Jr. and Larry Roberts &Susan Keen and Allan Larson and David Eisenhour(2015): Animal diversity, 7th edition, McGraw Hill Education Private Limited, 2015.

4.12 TERMINAL QUESTION/ ANSWER

1. Why reptiles are not found in coldest region of the world.
   They are ectothermic , they lacks an effective system for regulating their body temperature.
2. Why alligators lives near water
   They use water to maintain their constant body temperature.
3. Why snakes and lizards flick their tongue in air
   They use their tongue to capture scent particle which helps them to search foods.

UNIT 5 AVES

CONTENTS

5.1 OBJECTIVES

By the end of this chapter, you will know

1. General characteristics of Aves.
2. Classification up to order level
3. Study of skeleton of fowl.
4. Study of Museum specimen of Aves.

5.2 INTRODUCTION

Class Aves includes birds which are feathered, winged, bipedal (two legged), warm-blooded, egg-laying, vertebrate animals with evolutionary origin among the reptiles. Latin word for those vertebrate which have above characteristics is known as Aves. They have feathers, toothless beaked jaws, very high metabolic rate, forelimb modified into wings, a four-chambered heart, and pneumatic bones. Feathers are filamentous, lightweight, modifications of the outer skin that have remarkable aerodynamic qualities. The feathers are made up of keratin. Birds have lightweight hollow bones, well developed air –sac system and flow- through lungs. Hand (Fore limb) is made up of 3 digits. The bird wing comprises two sets of flight feathers, the outer primary feathers which are attached to the humorous, and the inner secondary feathers which are attached to the ulna.

5.3 GENERAL CHARACTERS

1. Aves (Birds) are warm-blooded with an exoskeleton of feathers.
2. Limbs paired; forelimbs usually modified for flying; (wings); posterior pair (hindlimb) adapted for

perching, walking, and swimming; foot with four toes.

3. Oil glands are present at base of the tail.
4. Fully ossified skeleton with air cavities.
5. Each jaw, without teeth covered with a keratinized sheath, forming a beak.

6.Erythrocytes sternum usually well developed with keel.

7. Sexes separate; testes paired, with the vas deferens opening into the cloaca.

8. Females have left ovary and oviduct only. Which opens into cloaca.

9. Parental care is well developed.

5.4 CLASSIFICATION UPTO ORDER LEVEL

Sub Class A. Archaeornithes:

1. Links between reptiles and bird.
2. Jaw contains teeth.

Example : Archaeopteryx(extinct)

Sub Class B. Neornithes:

1. **True birds.**

Super-order 1. Odontognathae:

1. Extinct toothed birds.
2. Clavicles not fused.
3. Sternum without keel.

Example :Hesperornis, Ichthyornis.

Super Order 2. Impennae:

Order 1: Sphenisciforms:

1. Forelimbs(wings) paddle like for swimming.
2. Bones are compressed.
3. Found in Antarctica and Galapapo islands.

Example : Penguins or Ratitae

Super Order 3: Palaeognathae:

1. Flightless Walking birds or running birds.
2. Wings reduced. No teeth.

Order 1. Struthioniformes:

1. Flightless, terrestrial and sternum without keel.
2. Public symphysis present.
3. Features without aftershafts.

Example : Ostrich.

Order 2. Causuariformes:

1. Flightless, terrestrial and sternum without keel.
2. 3 front toes on each foot.
3. Wings small

Example: Emu ,Cassowaries

Order 3: Apterygiformes:

1. Flightless, Terrestrial, Bill long and slender.
2. Wings degenerated. Humerus vestigial.
3. Feathers with large aftershafts.
4. **Example : Kiwis**

Order 4 Rheiformes:

1. Flightless, Terrestrial, Sternum unkeeled.
2. Head and neck partly featured.
3. Feathers lack aftershafts

Example: Rheas

Order 5: Tinamiformes:

1. Wings short, rounded , developed for flights.
2. Sternum keeled, Tail short

Example: Tinamus.

Order 6 :Aepyornithiformes:

1. Flightless, Sternum short, broad and unkeeled.
2. Wings vestigial

Example : Extinct elephant bird

Order 7: Dinornithiformes:

1. Flightless, Terrestrial, Sternum short and unkeeled.
2. Coracoid, scapula and wings bone absent.

Example: Extinct moas.

Super Order 4: Neognathae or Carinatae:

1. Modern flying birds. Jaw formed by beak without teeth.
2. Sternum keeled.

3. Wings well developed

Order 1: Gaviiformes:

1. Legs short, toes fully well developed.
2. Tail has 18 – 20 stiff features.

Example :Loons

Order 2: Podicipediformes:

1. Legs back on body. Feet lobed.
2. Tail tuft.

Example Grebes

Order 3: Procellariformes:

1. Feathers compact, oily in texture.
2. Nostril tubular. Beak covered by horny sheath.

Example: Albatrosses

Order 4: Pelecaniformes

1. All 4 toes included in footweb.
2. Nostril vestigial or absent.

Example: Pelican

Order 5: Ciconiiformes

1. Long necked, long legged .
2. Decorative features. Beak abruptlydecurved.

Example: Flamingo

Order 6: Anseriformes

1. Legs short, feet webbed.
2. Bill broadened.

Example: Ducks

Order 7: Falconiformes

1. Beak stout, hooked at tip.
2. Feet adapted for grasping with sharp claws.

Example: Eagle.

Order 8: Galliformes

1. Beak short, features with aftershaft.

2. Feet adapted for scratching and running.

   Example: Turkey

Order 9: Gruiformes

1. Features with aftershafts.
2. Weak or strong flight.

   Example: Crane

Order 10 :Diatrymiformes:

1. Beak huge, Flightless bird.
2. Tiny wings
3. 4 toes on each feet

   Example: Diatryma(Extinct)

Order 11: Charadriiformes

1. Toes webbed.
2. Features dense and firm.

   Example: Gulls

Order 12: Columbiformes

1. Beak short and slender.
2. Stout bodies.

   Example: Pigeons

Order 13: Cuculiformes

1. 2 infront, 2 behind toes.
2. Tail long. Beak moderate.

   Example: Cuckoos.

Order 14: Psittaciformes

1. Beak stout, narrow, sharp edged.
2. Features of blue, green, yellow or red color.

   Example : Parrot.

Order 15: Strigiformes

1. Head large , rounded.
2. Eyes large and directed forwards.

   Example : Owl

Order 16: Caprimulgiformes

1. Insectivorous , nocturnal
2. Beak small
3. Legs and feet small.

Example: Nightjars

Order 17: Apodiformes

1. Legs & feet very short.
2. Beak small .

Example : Humming birds

Order 18: Colliformes:

1. Tail very long
2. Strong claws and pamprodactyl feet.

Example: Mouse birds

Order 19: Trogoniformes

1. Weak legs.
2. Bill short and stout with bristles at base.
3. Feature are of green color.

Example: Trogons

Order 20: Coraciiformes:

1. 3^{rd} and 4^{th} toes fused at base.
2. Bill strong.

Example: *King fisher*.

Order 21: Piciformes

1. Bill stout owl like.
2. Zygodactyl feet

Example: Woodpecker

Order 22: Passeriformes

1. Anisodactyl foot.
2. No webbing and joining in toes.

Example: Crows, Sparrows

5.5 STUDY OF SKELETON OF FOWL

(A) Axial Skeleton:

1. **Skull (Dorsal View):**
    1. Skull Compact,devoid of teeth and very light due to spongy bones and presence of air cavities. Lightness is in accordance with flying habit.
    2. Distinct feature of skull is the presence of a long pointed beak without teeth. Skull bones very compact, cosely fused, polished and with obliterated sutures.
    3. Cranium greatly enlarged to accommodate the larger brain.
    4. Monocondylic,single occipital condyle articulates with atlas.
    5. Tropibasicskull – the definite inter-orbital septum separates large sized orbitals.

2. **Skull(Ventral View)**
    1. Supra-occipital joins with parietals forming a large prominent ridge known as occipital or lamboidal ridge.
    2. Tympanic cavity large, hemispherical and having a single columella.
    3. Teeth absent- Palate schizognathous formed by vomers, palatines, pterygoids and palatal prolongations of maxillae.

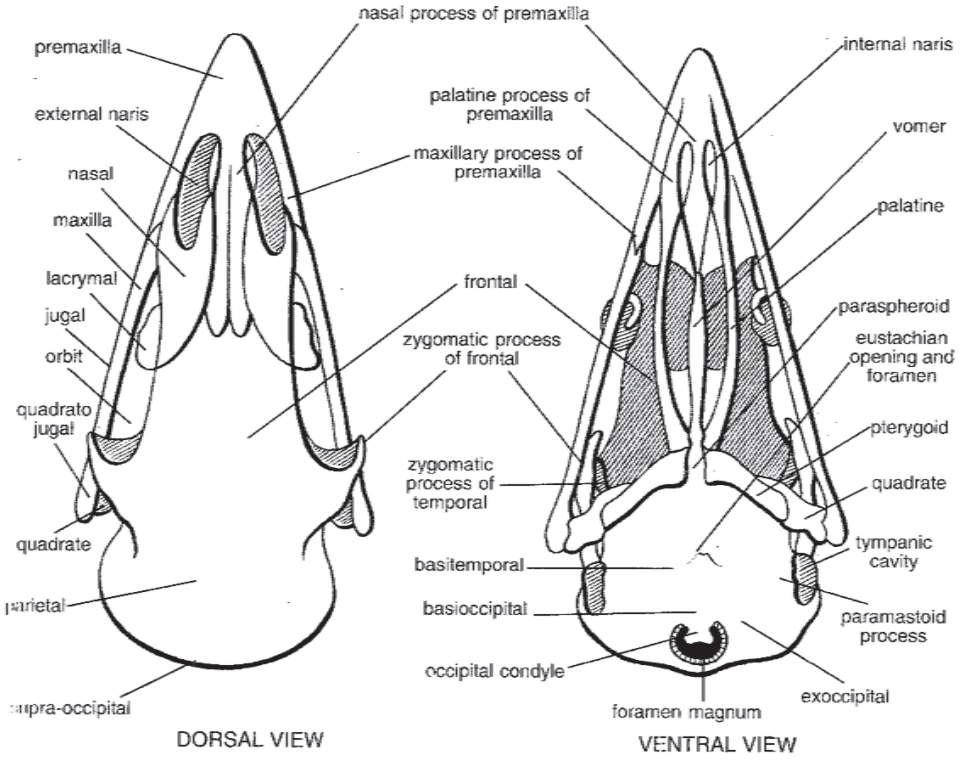

Fig. 5.1 Skull of Fowl in dorsal and ventral views

3. Disarticulated Skull Bones:-

1. Occipital Segment:-

1. It is the posterior most region of skull.
2. It contains a large foramen magnum and is composed of basioccipital below, exoccipitals on the sides and supraoccipital on the top.
3. Squamosal and parietal bones are not present in fowl.

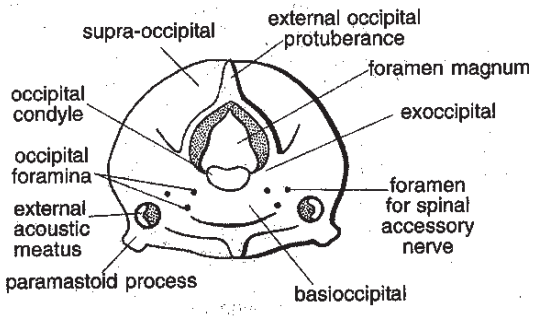

Fig. 5.2 Occipital Segment

2. Pterygoid:-

1. It is short and stout rod shaped bone.
2. They forms posterior boundary of mouth cavity.
3. It lies behind the palatine between the presphenoid rostrum and quadrate of its own side.

Fig. 5.3 Pterygoid

3. Nasals:-

1. The nasals form sides and roof of olfactory chambers.
2. They are separated by nasal process of pre-maxilla.

Fig. 5.4 Nasal

4. Premaxilla:-

1. It is a large triradiate bone formed by the fusion of the two premaxillae.

2. It forms the anterior most region of upper jaw and entire upper beak.
3. It produced into 3 processes namely nasal, maxillary and palatine.
4. Nasal process forms the upper margin of the external nares.
5. Maxillary process forms the margin of the upper jaw.
6. Palatine process are the one below maxillae and join with palatines.

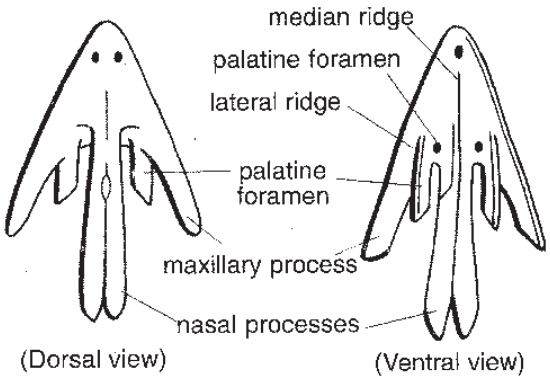

Fig. 5.5 Premaxillae

5. Maxilla:-

1. Maxilla is a rod shaped bone of anterior upper jaw.
2. It articulates with the nasal, maxillary process of pre-maxilla, vomer and jugal.

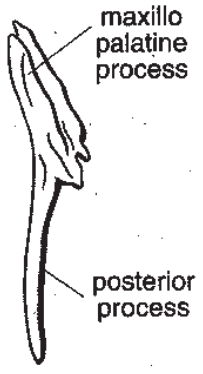

Fig. 5.6 Maxilla

6. Palatine : -

1. It is a slender horizontal bony bar located in front of pterygoid.
2. It lies within the ventral aspect of maxilla-palatine process and rostrum.

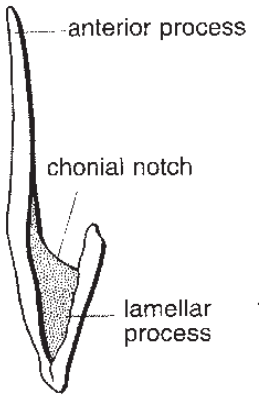

Fig. 5.7 Palatine

7. Lacrymal:-

1. It is found in orbital capsule.
2. A pair of lacrymals forms the anterior boundary of orbit.

Fig. 5.8 Lacrymal

8. Quadrate :-

1. It is a tough triradiate bone.
2. It is found in front of tympanic cavity.

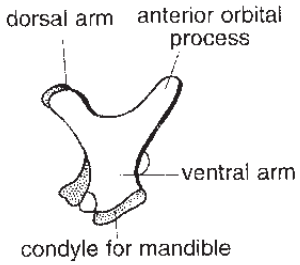

Fig. 5.9 Quadrate

9. Lower Jaws (Mandibles):-

1. The lower jaw is devoid of teeth.
2. Each ramus is made up of 5 bones namely Articular, Angular, Supra-angular, Splenial and Dentary.
3. **Articular** expands from posterior end of each ramus and is continued with Meckel's cartilage.
4. **Angular** lies below articular and forms lower border of jaw.
5. **Supra-angular** forms the upper margin of posterior mandible and contains a small coronoid process.
6. **Splenial** is a thin bone found along the inner surface of middle of mandible.
7. **Dentary** is the largest bone which forms anterior half of mandible and joins with fellow dentary at an anterior symphysis.

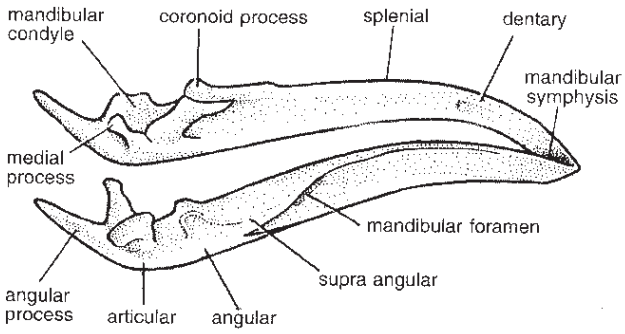

Fig. 5.10 Lower Jaws (Mandibles)

10. Hyoid Apparatus:-

1. It lies at the floor of mouth used to support tongue.

2. It is made up of a median jointed rod of cartilage and bone.

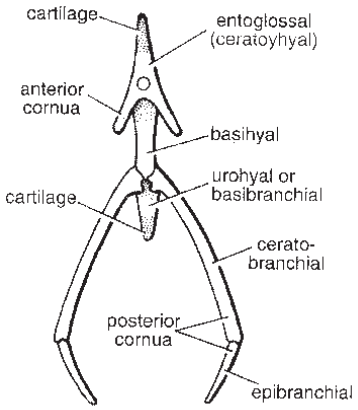

Fig. 5.11Hyoid Apparatus

(B) Vertebral column:

1. Atlas vertebra:-

1. It is the first vertebra of cervical region.
2. Small ring like in appearance.
3. Centrum, neural spine, transverse processes and prezygapophyses are absent.
4. It is formed of three pieces, a ventral and two dorso-lateral uniting mid-dorsally to form neural arch.

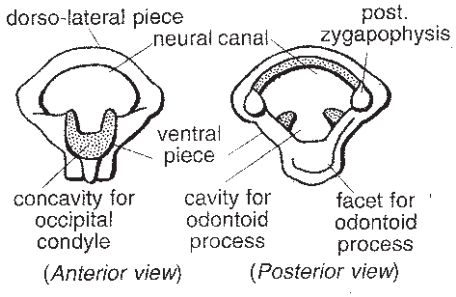

Fig. 5.12Atlas vertebra

2. Axis:-

1. It is the second vertebra of cervical region.

2. Centrum is produced in front into an odontoid process.
3. Transverse processes and ribs are absent.
4. Neural spine is blunt.
5. Pre and postzygapophyses are present.

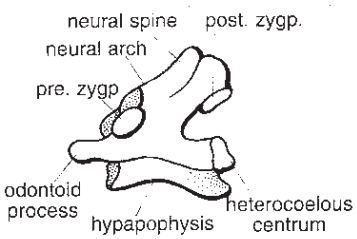

Fig. 5. 13 Axis

3. Typical cervical vertebra:-

1. Typical cervical vertebra (3rd to 10th) has a long body or centrum.
2. The centrum is heterocoelous or saddle shaped.
3. Anterior surface is concave from side to side.
4. Anterior surface is convex from above downwards.
5. Posterior surface is convex from side to side.
6. Anterior surface is concave from above downwards.

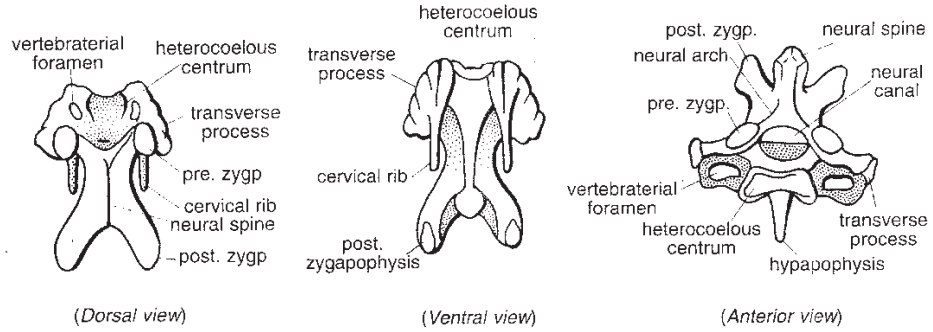

Fig. 5.14 Typical cervical vertebra

4. Fused thoracic vertebra:-

1. They are formed by the fusion of 2nd to 5th thoracic vertebrae.
2. Centrum is heterocoelous.

3. Their neural spines, transverse processes and hypapophyses are fused with each other.

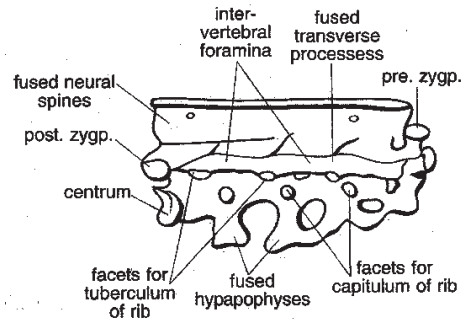

Fig. 5.15Fused thoracic vertebra (Lateral view)

5. Free thoracic vertebra:-

1. First and six vertebra are free thoracic vertebrae.
2. Centrum is heterocoelous. Neural Spines are elongated, pointed and well developed.
3. Transverse processes are well developed and outwardly directed.
4. Pre and postzygapophses are present on the anterior and posterior surfaces respectively.

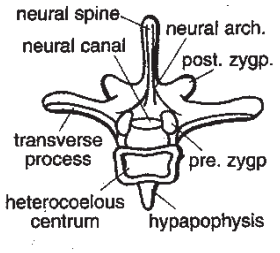

Fig. 5.16 Free thoracic vertebra (Anterior view)

6. Synsacrum:-

1. It is a long compound bone formed by the fusion of 14 to 16 vertebrae, supporting the ilium of the pelvic girdle on both sides.
2. Fused vertebrae of synsacrum are differentiated into last thoracic, six lumbars, two sacrals and seven caudal vertebrae.

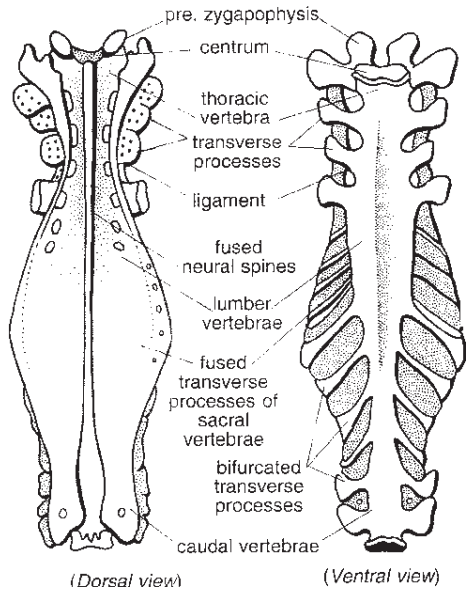

Fig. 5.17 Synsacrum

7. Caudal vertebrae:-

1. These bone are small.
2. These are last 4 or 5 vertebrae of tail.
3. Centrum is heterocoelous.
4. Neural spine are small and bifid.
5. Transverse process are somewhat cylindrical and directed downwards and outwards.
6. Pre and postzygapophyses are absent.

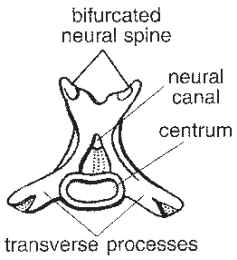

Fig. 5.18Free Caudal vertebrae

8. Thoracic rib:-

1. They are five flattened bony rods attached to the thoracic vertebrae.
2. Each thoracic rib consists of vertebral and sterna portions meeting at an angle.

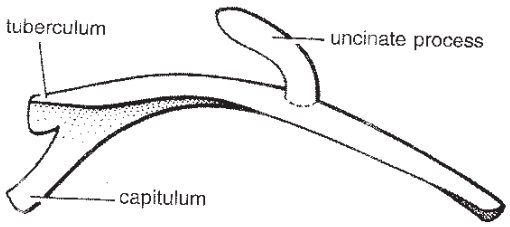

Fig. 5.19 Thoracic rib

9. Pygostyle:-

1. Pygostyle is the last fused vertebra of caudal region , commonly known as plough-share.
2. It is formed by fusion of four or more of the hindermost caudal vertebrae.
3. Centrum, neural spine, pre and postzygopophyses are absent.
4. It supports tail feathers.

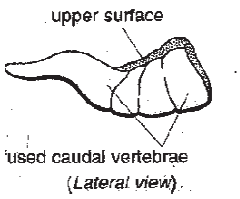

Fig. 5.20 Pygostyle

(C) Sternum:

1. It is a broad bone lying in the breast region, also known as breast bone.
2. It is a boat shaped bone present in the ventral thoracic region and consists of the following parts namely Manubrium, Keel, Metasternalprocess,Costal surface ,Costal process and Coracoid grooves.
3. Manubrium is small plate like structure arising vertically from the anterior end of the ventral surface of the body of sternum.
4. Keel is a triangular stout bony plate projecting vertically downwards from the ventral side of the body of sternum.

5. Metasternal process are pair of large process on the sides of the anterior end of the body of sternum
6. Costal surface are four cup like depression in the dorso-lateral margins of anterior part of the metasternum.
7. Costal process are the process which arise from the anterior end of the body surface and projects in front of pair of anterior lateral metasternal process.
8. Coracoid grooves are deep transverse grooves lying at the base of manubrium and communicate with each other through a hole.

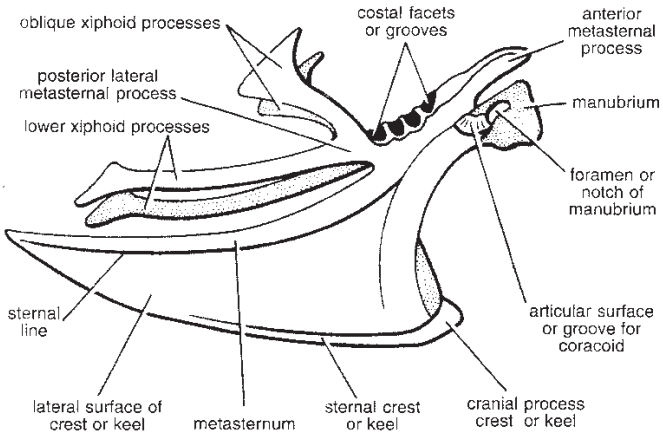

Fig. 5.21 Sternum

(D) APPENDICULAR SKELETON

1. Pectoral Girdle:-

1. Pectoral girdle is very stout bony structured connected with sternum on either side to support wings.
2. On either side consists of a scapula,coracoids and a clavicle.
3. Scapula is long flattened bone lying above the thoracic ribs and parallel to the vertebral column.
4. On its anterior outer side it bears shallow depression forming a part of glenoid cavity and its inner surface is produced into an acromian process.

5. Coracoid is stout straight bone directed downwards and articulates with the articular surface of coracoids on the antero-lateral edge of the sternum at the base of manubrium.
6. Clavicles are a pair of slender curved bones connected by their expanded upper ends with the coracoids and scapula.

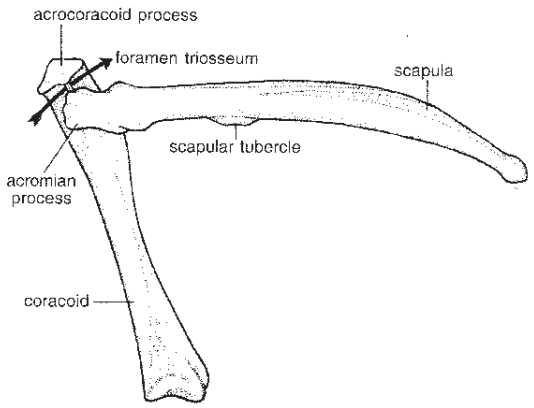

Fig. 5.22 Pectoral Girdle

2. Pelvic Girdle:

1. Pelvic Girdle consists of two separate halves lying on either side of the synsacrum.Each half is known as os-innominatum.
2. Each os-innominatum comprises of ilium, ischium and pubis.
3. Ilium is an elongated and remarkably expanded bone extending both anterior and posterior to the acetabulum.
4. Ischium is dorso-ventrally flattened bone projecting backwards behind the acetabulum and parallel to the posterior part of ilium.
5. Pubis is a long slender bone directed backwards parallel to the outer margin of ischium with which it is fused.
6. At the junction of three bones on outer side is present a concavity, the acetabulum for the articulation of head of femur.

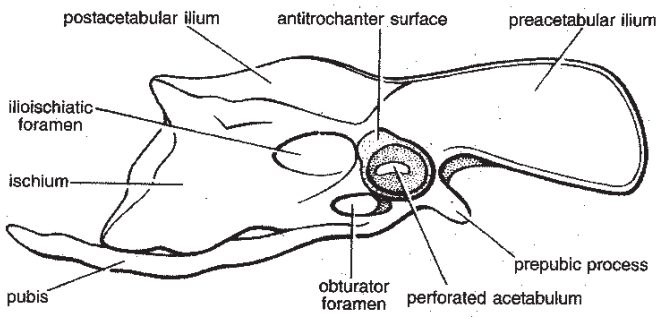

Fig. 5.23 Pelvic Girdle

(E) FORELIMB BONES:-

1. **Humerus:**
    1. Humerus is the bone of upper arm of fore-limb.
    2. It is an elongated stout bone expanded at both the ends.
    3. The proximal end contains a convex head, which bears one smallermooth convex surface the head which fits into the glenoid cavity.
    4. The head is bordered by preaxial and postaxial tuberosities.
    5. The distal end posseses a trochlear surface for the articulation with radius and ulna.

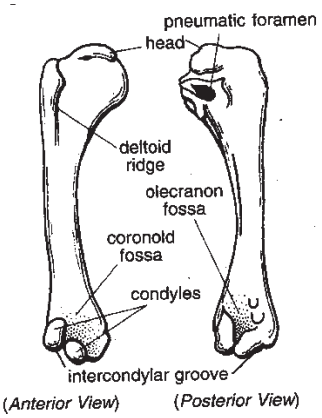

Fig. 5.24 Humerus

2. **Radius and Ulna:**
    1. They both are separate bones.
    2. Radius is short, slender and straight bone.

3. Proximal end of radius has a cavity for outer condyle of humerus and distal end fits into radiale carpel.
4. Ulna is stouter and larger than radius & also slightly curved.
5. Its proximal end contains a facet for inner condyle of humerus and is produced as olecranon process.

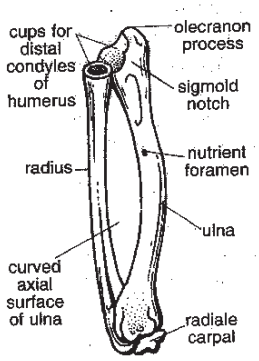

Fig. 5.25 Radius and Ulna

3. Carpals:

1. Carpals are two irregular bones of wrist.
2. Pre axial radiale is smaller and articulates with the radius.
3. The post axial ulnare is larger and articulates with the ulna.

4. Carpo-metacarpus:

1. It is the bone of manus or palm.
2. It is a compound bone formed by fusion of three metacarpals with the distal row of carpels.
3. First metacarpal is short and stumpy.
4. Second metacarpal is strong and straight bone.
5. Third metacarpal is thin, slightly curved on the postaxial side and fused at both the ends with second metacarpal.

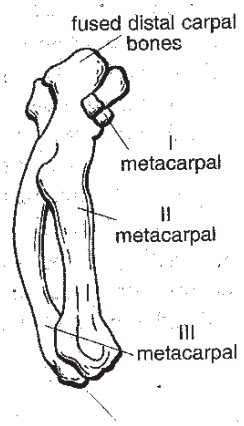

Fig. 5.26 Carpo-metacarpus

5. Phalanges:

1. Three digits only.
2. Polex (First digit)- has a single phalanx.
3. Index or second digit- has two phalanges.
4. Third digit- has only one phalanx.

(F) HIND LIMB BONES:-

1. Femur:

1. Femur is the bone of thigh of hind limb.
2. It is short and powerful bone enlarged at both ends.
3. On the outer side of the head is an irregular process, the great trochanter.
4. It has a deep groove or intercondylar fossa bounded laterally by two condyles for the articulation with the tibia and fibula.

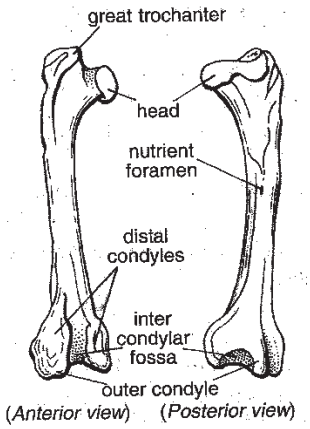

Fig. 5.27 Femur

2. Tibiotarsus and fibula

1. Tibiotarsus and fibula are the bones of shank of hind-limb.
2. Tibiotarsus is formed by the fusion with the proximal row of tarsals.
3. Fibula is small, slender bone.
4. Fibula articulate with femur.

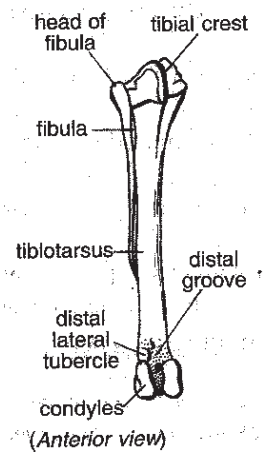

Fig. 5.28 Tibiotarsus and fibula

3. Tarsals:

1. In adult birds, the proximal row of tarsals are fused with tibia and distal row with meta-tarssus.

2. In between the two rows is present the inter-tarsal ankle joint.

4. Tarso-metatarssus:

1. It is a compound bone of foot.

2. It is formed by the fusion of distal row of tarsals with the second, third and fourth meta-tarsals.

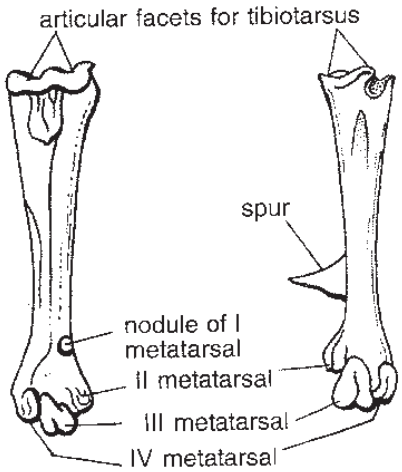

Fig. 5.29 Tarso-metatarssus (A) Female (B) Male

5. Phalanges:

1. These are small slender bones.

2. Metatarsus carries four toes: first or hallux is directed backward, remaining three are directed forward.

5.6 STUDY OF MUSEUM SPECIMEN

1.*Psittacula*

General Characteristics:

1. *Psittacula* is commonly known as Tota in Hindi. They are also known as parrotor Indian parakeet in English.
2. Body is slender with a long pointed tail.
3. Body length is about 25 cm.
4. Body color is grass green.
5. In male black & rose pink collar is present, it is absent in female.
6. Typical red bill is short, stout and deeply hooked.
7. Feet are adapted for grasping, holding and climbing.
8. Herbivorous comprises mainly fruits.
9. It makes its nest in hollow tree trunks and holes in buildings.

Identification: Parrot is a popular domesticated cage bird, It copies and speaks some words like man.

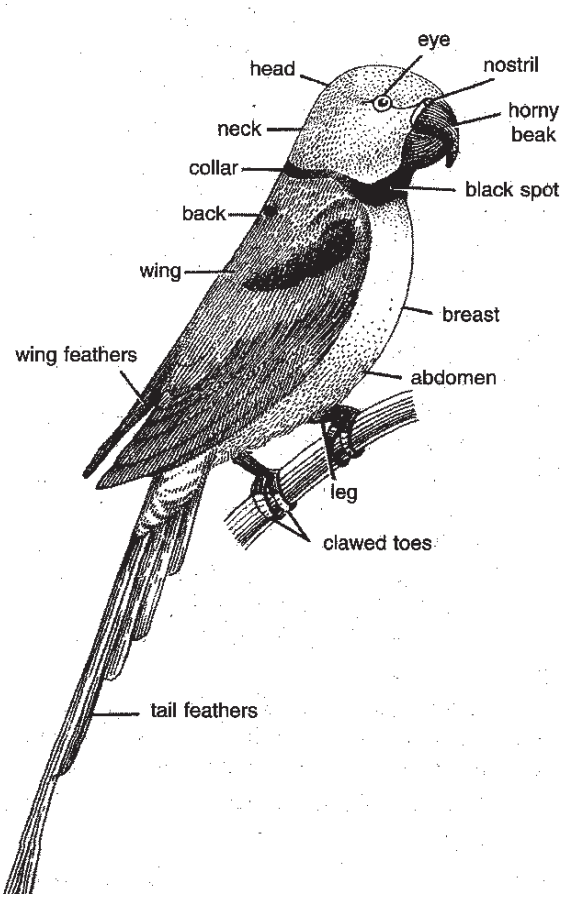

Fig.5.30 Psittacula(Parrot)

Systematic position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Class : Aves -> Warm Blooded, Terrestrial vertebrates, fore-limbs modified into wings,hind-limbs for walking,perching or swimming, skull monocondylic, beak present, respiration by lungs, heart with two auricles and two

ventricles, oviparous, amnion, allantois and yolk sac

Subclass : Neornithes -> Tail short, teeth absent,metacarpels fused with distal carpels, claws absent in fore-limbs, sternum well developed,vertebraeheterocoelous.

Superorder: Neognathae -> Skull neognathus,feature having interlocking mechanism, wings well developed, sternum well developed, tail vertebrae are 5 or 6

Order : Psittaciformes -> Green, Yellow or Red Feathers, Beak Stout, sharp-edged and hooked on tip, feet zygodactylus, outer toe not reversible

Genus : *Psittacula*

Species *: krameri*

2.*Corvus*

General Characteristics:

1. Corvus is commonly known as Koowa in Hindi. They are also known as House Crow in English.
2. Body length vary from 32 to 42 cm.
3. The neck and breast is grey in color.
4. Eyes are large and beak stout and elongated.
5. Feet adapted for perching, 3 toes in front and 1 behind.
6. Omnivorous.
7. Their nest comprises of twigs arranged in a cup like depression lined with hay etc,

Identification:since the above bird has raised head and above features, hence it is *Corvussplendens.*

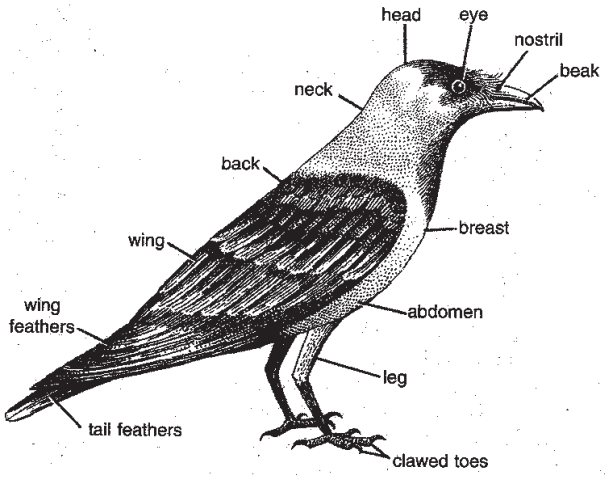

Fig. 5.31 Corvus splendens

Systematic position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Class : Aves -> Warm Blooded, Terrestrial vertebrates, fore-limbs modified into wings,hind-limbs for walking,perching or swimming, skull monocondylic, beak present, respiration by lungs, heart with two auricles and two ventricles, oviparous, amnion, allantois and yolk sac

Subclass : Neornithes -> Tail short, teeth absent,metacarpels fused with distal carpels, claws absent in fore-limbs, sternum well developed,vertebraeheterocoelous.

Superorder: Neognathae -> Skull neognathus,feature having interlocking mechanism, wings well developed, sternum well developed, tail vertebrae are 5 or 6

Order : Passeriformes -> Toes three in front and one behind, adapted for perching,

cutting beaks.

Genus : *Corvus*

Species : *splendens*

3.*Pavo*

General Characteristics:

1. *Pavo* are commonly known as Mor or Mayur in Hindi. They are also known as Peacock.
2. The gorgeous occellated or eyed trail of the cock is actually not his tail but abnormally lengthened upper tail coverts. Peahen has no such coverts.
3. Bill is short.
4. Feet is adapted for scratching and running.
5. Features are with aftershafts.
6. Omnivorous .
7. They lives in groups.
8. They have good eye sight and hearing .
9. They lay 3 -5 eggs at time. The egg are pale-cream in color.

Identification: Bird has characteristic feathers with eyes.

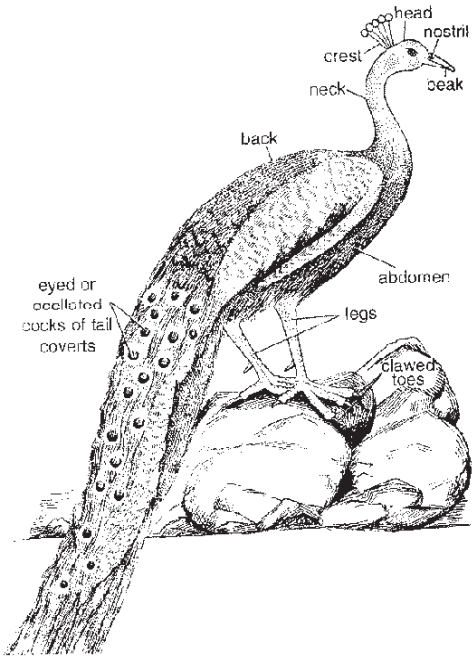

Fig. : 5.32 Pavo cristatus

Systematic position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata ->Jaws and paired appendages are present

Class : Aves -> Warm Blooded, Terrestrial vertebrates, fore-limbs modified into wings,hind-limbs for walking,perchingor swimming, skull monocondylic, beak present, respiration by lungs, heart with two auricles and two ventricles, oviparous, amnion, allantois and yolk sac

Subclass : Neornithes -> Tail short, teeth absent,metacarpels fused with distal carpels, claws absent in fore-limbs, sternum well developed,vertebraeheterocoelous.

Superorder: Neognathae -> Skull neognathus,feature having interlocking mechanism, wings well developed, sternum well developed, tail vertebrae are 5 or 6

Order : Galliformes ->Terrestial birds with short and powerful flights, short beak, features with aftershaft, graminivarous, scratching and running adapted feets

Genus : *Pavo*

Species : *cristatus*

4.*Bubo*

Comments:

1. *Bubo* are commonly known as Ghughu or ulloo in Hindi. They are also commonly known as Great horned owl.
2. They are large, heavy and robust bird, measuring upto 60 cm in length.
3. Body color is dark brown .
4. Head is large, rounded and bears two conspicuous black ear tufts or horns.
5. Eyes are large, round, yellow or orange gold and directed forwards.
6. Legs are fully feathered. Feet adapted for grasping; claws sharp.
7. Carnivorous.

8. Nesting season November to April.
9. They are nocturnal birds feeding on rodents, birds, and small reptiles.

Identification: Bird has large forwardly directed eyes and above features.

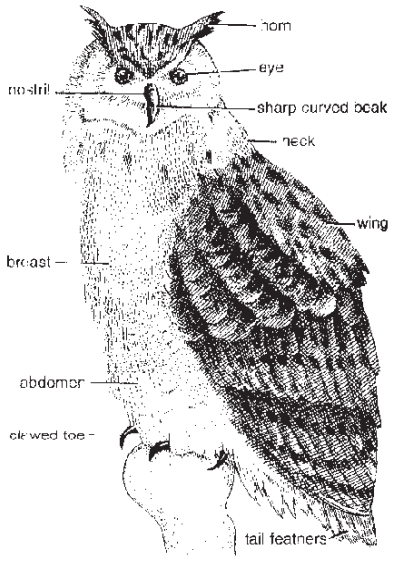

Fig. 5.33 Bubo bubo

Systematic position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata -> Definite head and cranium with brain.

Subphylum: Vertebrata -> Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata ->Jaws and paired appendages are present

Class : Aves -> Warm Blooded, Terrestrial vertebrates, fore-limbs modified into wings, hind-limbs for walking, perching or swimming, skull monocondylic, beak present, respiration by lungs, heart with two auricles and two ventricles, oviparous, amnion, allantois and yolk sac

Subclass : Neornithes -> Tail short, teeth absent, metacarpels fused with distal carpels, claws absent in fore-limbs, sternum well developed, vertebraeheterocoelous. Superorder: Neognathae -> Skull neognathus, feature having interlocking mechanism, wings well developed, sternum well developed, tail vertebrae are 5 or 6

Order : Strigiformes -> Head large and rounded, eye large and directed forward, retina contains rods, ear opening large, beak short, sharp claws feet, nocturnal, predators.

Genus : *Bubo*

Species : *bubo*

5. model/chart of Archaeopteryx:

General characteristics:

1. Fossilized *Archaeopteryx lithographica* was discovered by Andres Wagner in 1861 from the Jurassic Lithographic limestones of Bavaria in Germany during Jurassiac period.
2. This bird was about the size of a crow with a long tapering tail like that of a typical dinosaur.
3. Head contained eye, nostril and toothed beak.
4. Whole body was covered by scales.
5. Forelimbs modified into wings with feathers.

3.*Archaeopteryx* is a transitional converting link between reptiles and bird. Both characteristics of Bird and

Reptiles are shown by it. Thus there was a controversy as it was reptile or aves. It can't be called as true bird or true reptiles.

This transition has been shown below :

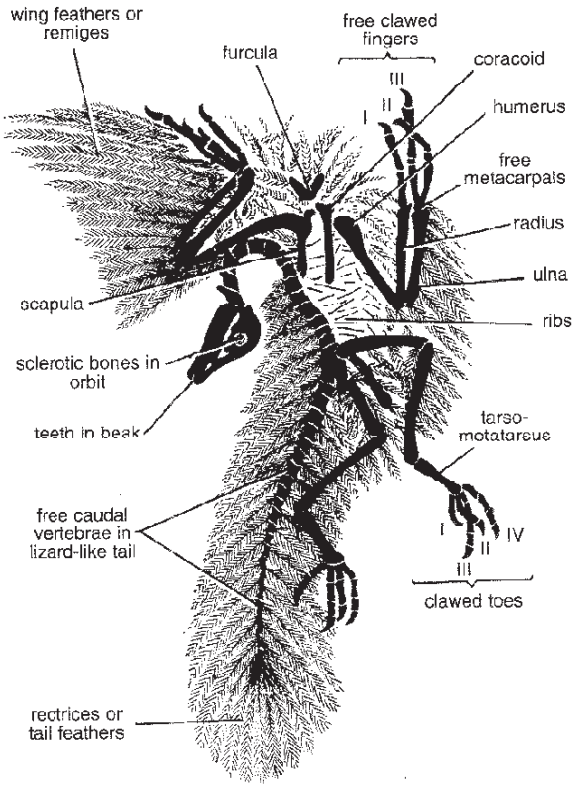

Fig. 5.34 Archaeopteryx

Reptilian Characteristics:

1. Scales are present on the body and limbs.
2. Long, lizard like tail with 20 free caudal vertebrae.
3. Bones are not pneumatic.
4. Cervical vertebrae are fewer(9 or 10) than other birds.
5. Centra of vertebrae are amphicoelous.
6. Sternum is poorly developed.
7. Eyes with sclerotic ossicles.
8. Brain was simple with cylindrical cerebral hemisphere.

Avian Characteristics:

1. Presence of feathers.
2. Fore limbs modified into wings.
3. Tail bears two rows of feathers.

4. Jaws are modified as beak.
5. Skull is large, monocondylic with round brain case.
6. Eyes with sclerotic ossicles.
7. V shaped furcula is present.
8. Tibia and fibula are separate.

5.7 SUMMARY

Class Aves (L., avis, birds; Gk. Ornis, birds) includes vertebrate animals which are warm blooded, forelimbs modified as wings, body covered with feathers, such as Ostrich, crow, kite, penguins etc. It is a very successful, diverse and widespread group, with about 9,000 species. Study of birds is known as Ornithology'

Aves can be segregated into two sub classes: Archaeornithes (rchios = ancient; ornithes=bird) and Neornithes (Neos= modern; ornithes=bird). SubClass Archaeornithes have amphicoelous vertebrate where SubClass Neornithes are heterocoelous.

Birds are of special economic importance to man. Birds are commercially reared for meat and eggs(hen, duck & turkey) to be used as human food and body parts as medicines. Theirs feathers are used for ornamental purposes. They are also useful in agriculture used as pollinator, fertilizer and control of pest. Birds used to destroy fruits, vegetables resulting in economical loss to farmers.

Birds concentration indicate the richness of the ecosystem. Birds acts as scavengers, foods for small mammals, reptiles etc. Thus contributing in food chains. Though some birds are also carnivorous feeding on small birds and fishes.

5.8 GLOSSARY

Allantois: One of the extra embryonic membrane arising as a pouch from hindgut in embryos of amniotes.

Amniotes: Group of vertebrates in which extra embryonic membrane (amnion and allantois) surround the developing embryo.

Amphicoelous: Concave at both ends

Anisodactyl: having three toes free and face forward and hind toe are opposable to them.

Carnivarous.: Animals feeding on other animal.

Carpals: Bones of wrist

Caudal: Pertaining to tail

Centrum : Main ventral body of a vertebra which bears numerous processes for muscle attachment.

Cervical: Related to neck region

Cloaca: common passage for discharge of digestive, excretory and reproductive products in vertebrates except mammals.

Cranial : related to skull or brain

Dermis: Inner connective tissue layer of skin.

Exoskeleton: Hardened supporting structure outside body of animal

Heterocoelous: Anterior end is convex in vertical section, concave in horizontal section, while posterior end have these outline reversed.

Hyoid : Y shaped group of bones and cartilage at the base of tongue

Monocondylic: Single occipital condyle is present above basioccipital.

Nocturnal: Active in night

Notochord: Rod like cellular skeletal axis found in chordate embryo or adult.

Occipital: Pertaining to base of skull of vertebrate.

Omnivorous: Feeding on all kinds of food, plants and animal

Ossicle: A small bone

Pamprodactyl: Having toes turn forward

Pelvic Girdle: Structure of hip to which hind limbs are attached

Ramus: Abranch of blood vessel, bone or nerve.

Uncinate: Hooked

Warm –blooded: Animals who regulates constant body temperature.

Zygapophyses: Process from neural arch of a vertebra for articulation with those of adjacent vertebrae.

Zygodactylus: Two toes infront and two toes behind.

5.9 SELF ASSESSMENT QUESTION

1. *Archaeopteryx* is a connecting link between
   a) Amphibians and birds b) Reptiles and Birds
   c) Amphibian and reptiles d) Birds and Mammals

2. Jaws in birds have modified into
   a) Head b) beak c) eyes d) none

3. Wings in bird are modified
   a) Hind limb b) Fore-Limb c) Depends on Birds d) None

4. National Bird of India
   a) *Psittacula* b) *Corvus* c) *Pavo* d) *Bubo*

5. Feathers in bird helps in
   a)Heat Regulation b) Sexual Display c) Flight d)All

6. Feathers of Bird are made up of
   a) Keratin b)Protein c) Fat d) Lipids

7. If a bird is shifted from 20^0 C to 30^0 C then body temperature will be
   a) 20 b) 30 c) No Change d) 25

8. Parental care in bird is
   a) Developed b) Well Developed c) Intermediate d) No Care

9. Which one of the following activities is fastest comparable to other animal

a) Heart Beat b) Digestion rate c) Breathing d) Chewing

Answer:

1(b) 2(b) 3(b) 4(c) 5(d)6(a)7(c) 8(b) 9(c)

5.10 REFERENCES

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- **Lal, S. S. (2015)**: Practical Zoology Vertebrates. Rastogi Publication Meerut.
- **Pandey, B.N. (2015)**: Animal Diversity Volume 1.Tata McGraw Hill Education Private Limited Delhi.

5.11 SUGGESTED READING

Cleveland Hickman, Jr. and Larry Roberts &Susan Keen and Allan Larson and David Eisenhour: Animal diversity, 7th edition, McGraw Hill Education Private Limited, 2015.

5.12 TERMINAL QUESTION

1. Why breathing rate is highest in bird comparable to other animal?
   Breathing rate is highest to support rapid beating of wing.
2. What is the need to have light weight bones with large air cavities?
   Light weight bones allows the birds to reduce its weight and assist in flight.
3. Why Birds have a larger hearts than mammals(relative to body size and mass)?
   This is so to support high metabolic rate.
4. How air sacs make the body light?
   The air sacs contains warm air

UNIT 6: CLASS- MAMMALIA

CONTENTS

6.1 OBJECTIVE

By the end of this chapter, you will know

1. General characteristics of mammals.
2. Classification up to order level
3. Study of slides of organs of mammals.
4. Study of skeleton of mammals by taking rabbit as example.
5. Study of Museum specimen of mammals.

6.2 INTRODUCTION

Mammals are vertebrates within class Mammalian (from latin word mamma meaning “breast”). Mammals are warm blooded, possession of neocortex (region of brain), hair, three middle ear bones and mammary glands.

6.3 GENERAL CHARACTERS

12. Body covered with hairs (except Cetacea).
13. Sweat and oil glands are present in the skin.
14. Mammary glands are present(functional in females).
15. They are warm blooded animals.
16. External ear are present.
17. Two occipital condyle.
18. Respiration by lungs.
19. Heart is four chambered with only one a left aortic arch.
20. Seven cervical vertebrae.
21. Fertilization internal.
22. Teeth are heterodont, thecodont and diphyodont.
23. Kidney is metanephric type(meta nephros)

Classification:

Sub class (A) Prototheria(Egg Laying mammals)

3. Mammary glands are without nipples.
4. Vertebrae are without epiphyses.
5. Cloaca is present.

.

Order 1: Monotremata

3. Pectoral girdle posseses large coracoid bones and interclavicle.
4. No corpus callosum in brain.
5. Found in Australia, Tasmania and New Guinea.

Example. ***Ornithorhynchus(Platypus), Echidna.(Spiny ant-eater)***

Sub class (B)Theria(youngones giving birth mammals)

3. Mammary Glands with Nipples.
4. Ear with external pinna.
5. Cloaca is absent, oviducts open into vagina.

Infraclass I: Metatheria

1.Brood pouch (Marsupium) is present in female.

2.Mammary glands are sebaceous and bearing nipples.

3. Vagina and uterus are double.

4. Placenta is usually absent.

Order 1: Marsupialia

1. Epipubic bones are present and attached with pubis.
2. Vertebrae with epiphyses.
3. Separate coracoid and interclavicle are absent.

Example: *Macropus (Kangaroo)*

Infraclass II : Eutheria

1. Mammary glands with Nipples.

2. Epipubic bone are absent.
3. Clooca is absent.
4. Placental mammals.

Order 1: Insectivora

1. Small and Furry Animals.
2. Snout long and tapered.
3. Teeth sharp and pointed.

   Example: *Talpa*(Mole).

Order 2: Dermoptera

1. Commonly known as "Flying Lemurs".
2. Membranes stretched between fore and hind limbs.
3. Noctural (Night Actiove)

   Example: *Galeopithecus*.

Order 3: Chiroptera

1. Known as "True Flying Mammals". (Bats)
2. Fore limbs are modified for flight.
3. Hind limbs are weak, vision is weak.

   Example: *Pteropus*

Order 4: Primates

1. They are known as Arboreal and Terrestrial mammals.
2. Hands and feet are more or less prehensile.
3. Mode of walking is Plantigrade.
4. Head turns readly on neck.

   Example: Monkeys, Ape, Man.

Order 5: Edentata

1. Toes clawed.

2. Clavicle is present.
3. Coracoid fused with acromian.
   Example: Sloth, Armadillos

Order 6: Pholidota

1. Horny scales on body.
2. Snout is elongated.
3. No Teeth, Tongue slender for capturing insects.
   Example: *Manis*(Scaly ant eater)

Order 7: Lagomorpha

1. Testes are always external in the scrotum.
2. Two pairs of incisors are there in upper jaw.
3. Soles of feet are hairy.
4. Tail is short.
   Example: Rabbits, Hares

Order 8: Rodentia

1. Small Mammals.
2. Limbs with five toes and claws.
3. One Pairs of upper incisors
4. Canines are absent.
   Example: Guinea Pig, *Rattus Lattus*(House rat).

Order 9: Cetacea

1. Medium to large sized.
2. Body is Fish like and Marine.
3. Head long without neck.
   Example: Whales,Dolphins.

Order 10: Carnivora

1. Small to large terrestrial carnivores.
2. Teeth are sharp, canines are well developed.
3. Toes never less than four, strong and sharp claws.

   Example: *Panthera leo*(Lion), Panthera Tigris (Tiger)

Order 11: Tubulidentata

1. Body stout and pig like.
2. Ears are long erect and pointed.
3. Snout is long and tubular with round nostril at the tip.

   Example: *Orycteropus*(Aard-vark).

Order 12: Proboscidea

1. Largest terrestrial mammals.
2. Long proboscis or trunk (elongated nose), upper lip bearing the nostrils at the tip.
3. Legs pillar like.

   Example: *Elephas indicus*(Indian Elephant)

Order 13: Hyracoidea

1. Small rabbit like animal with split snout.
2. Ears are short and tail is much reduced.
3. Four digits in fore-limbs and three digits in hind-limbs.

   Example: Procavia.

Order 14: Sirenia

1. They are commonly known as sea cows.
2. Body stream-lined or spindle shaped.
3. Fore limbs have been modified as paddles while hind limbs are absent.

   Example: *Halicore dugong*(Dugong)., Manatee (Sea Cow)

Order 15: Perissodactyla

1. Large sized hoofed mammals.
2. Teeth are lophodont.
3. Stomach is simple Caecum large and sacculated.
   Example: *Equus* (Horse), Zebra. And Rhinoceros

Order 16: Artiodactyla

1. Terrestrial and semi-aquatic mammals.
2. Teeth are selenodont or bunodont.
3. Stomach is complicated and caecum is small.
   Example: Deer, Cow. Camel, Sheep and Pig.

6.4 STUDY OF PERMANENT SLIDES OF MAMMALS

V.S of skin of a mammal:

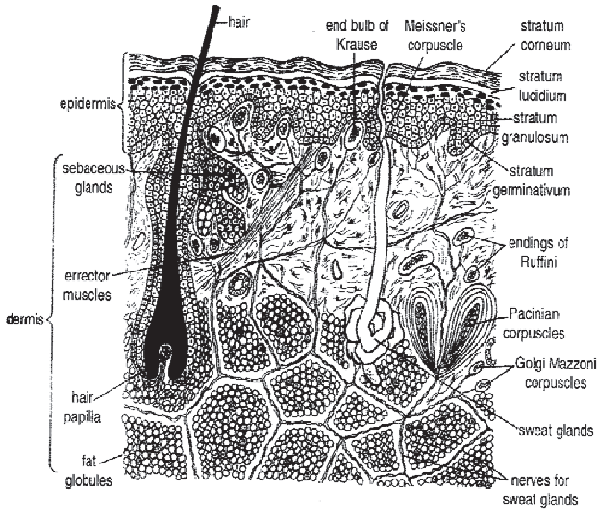

Fig 6.1 V.S of Skin of Mammals

Comments:

1. Glands and Hairs are found in abudance on the surface of skin.
2. Skin is made up of three layers namely ectodermal epithelium, epidermis and dermis.
3. Epidermis comprises of outer layer stratum corneum followed by stratum lucidium, straum granulosum and Stratum Malpighii as the inner most layer.
4. Stratum corneum are a nucleate broad flat scales.They are formed by epidermal kerantinization.
5. stratum lucidium are flat cells without granuales.
6. straum granulosum are made up of granular cells.
7. Stratum Malpighii are inner most layer . New cells are budded off and move upwards.
8. Dermis has dense areolar connective tissue, muscle fibres, blood vessels, nerves and glands.

T.S of Liver of a mammal

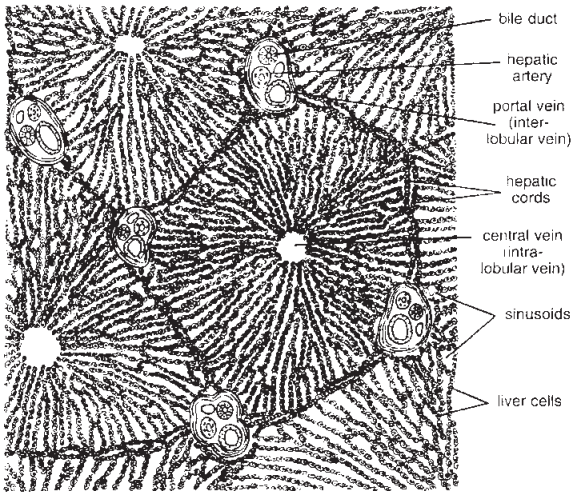

Fig 6.2 T.S of Liver of mammal

Comments:

1. Liver has a polygonal lobules containing central vein(intra-lobular) in centre, and portal canals at the corners.
2. Polygonal lobules separated by a thin layer of connective tissue septa or Glissons capsule.
3. Each portal canal consists of connective tissue strand , hepatic artery, bile duct and lymph vessels.
4. Hepatic lobule is connected with a network of sinusoid.
5. Kupffer cell are found at intervals on the walls of sinses.
6. Liver secretes bile that contains bile salts, pigments and toxins.

T.S of Pancreas of a mammal:

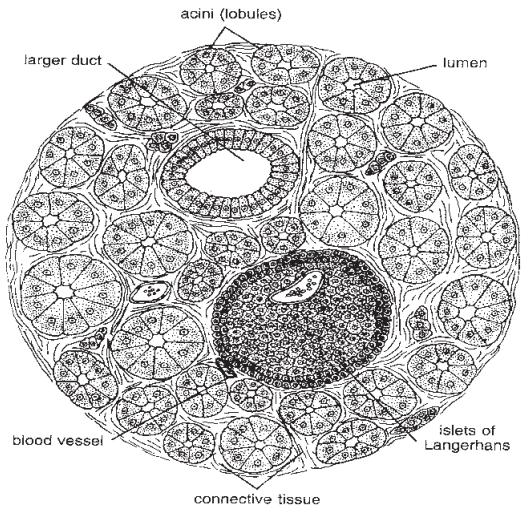

Fig 6.3 T.S of Pancreas of Mammal

Comments:

1. Pancreas consists of both exocrine and endocrine portion.
2. Exocrine portion contains a series of lobes and lobules or acini.
3. Acini are bound by connective tissue containing blood vessels, nerves and lymph vessels.
4. Exocrine portion secrets pancreatic juice.
5. Endocrine portion composed of Islets of Langerhans found between acini.
6. Islets of Langerhans secretes insulin and glucogon hormones.

7. Insulin is secreted by beta cells of Islets of Langerhans and glucogon by alpha cell

T.S of Spleen of a mammal:

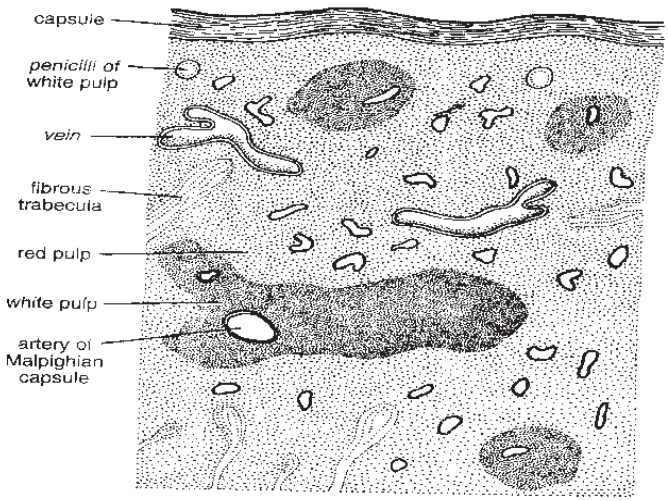

Fig 6.4 T.S of Spleen of mammal

Comments:

1. Spleen is covered by a thin capsule made up of fibrous connective tissue and involuntary muscles.
2. Capsule sends trabeculae, forms a network in substance of the gland.
3. Spleen is composed of lymphatic tissue distinguished into white pulp and red pulp.
4. White pulp is made up of reticular fibres and form sheath around arteries.
5. Red pulp contains erythrocytes, capillaries and venous sinuses.

T.S of Lung of a mammal:

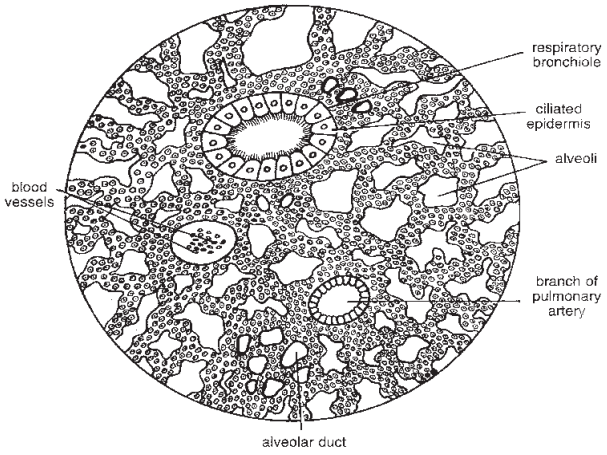

Fig 6.5 T.S of Lung of Mammal

Comments:

1. Lung is comprised of bronchioles, alveoli, blood vessels,lymphatic vessels and nerves.
2. Bronchi are lined by ciliated epithelium resting with basement membrane.
3. Alveolus is a network of capillary blood vessels in connection with pulmonary artery or vein of the lung.
4. Alveoli form clusters which open in a alveolar duct.
5. Bronchioles have lumen.
6. Air is taken into alveoli by the respiratory bronchioles through alveolar ducts which get it from bronchioles which in turn get it from the bronchus.
   Air -> trachea -> bronchus -> bronchioles -> respiratory bronchioles -> alveolar ducts -> alveoli ->gaseous exchange takes place and CO_2 is taken out.

L.S of Kidney of a mammal

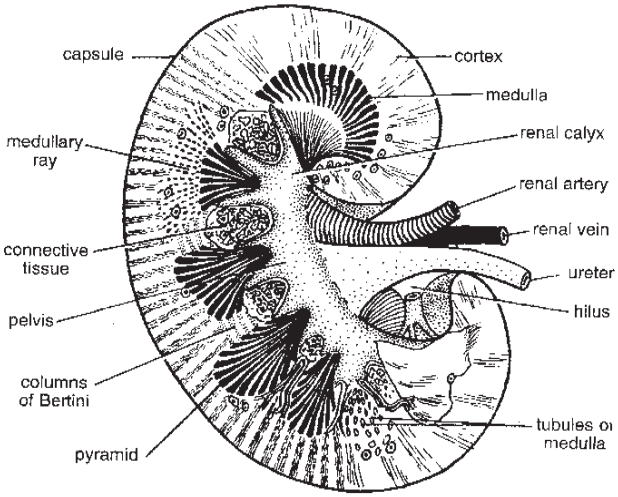

Fig 6.6 L.S of Kidney of mammal

Comments:

1. Kidney is metanephric, compact, bean shaped.
2. Kidney is surrounded by a capsule of dense connective tissue.
3. Kidney is protected by peritoneum only at ventral surface.
4. Glandular part of kidney composed of outer cortex and inner medulla.
5. Cortex contains numerous uriniferous tubules, malpighian capsules having Bowman capsules and glomerulus scattered throughout.
6. Medulla is made up of several renal pyramids, medullary rays, columns of Bertini, tubules of medulla and connective tissue.
7. A depression is present in the center of the concave surface of the kidney, is known as hilus.

T.S of Testis of a mammal:

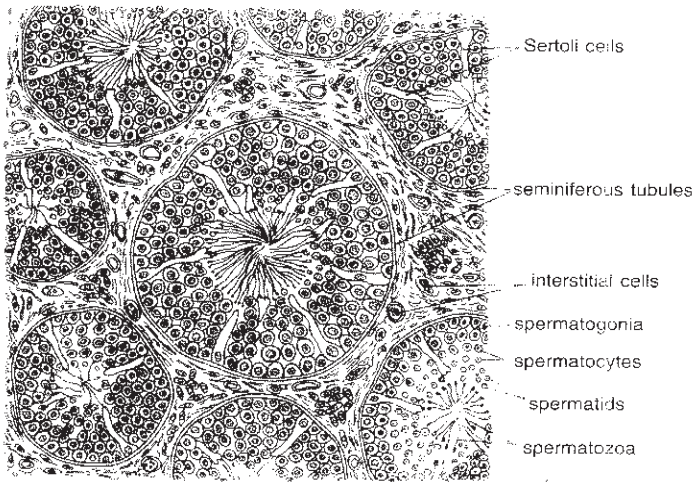

Fig 6.7 T.S of Testis of Mammal

Comments:

1. Testis is round or oval in shape surrounded by peritoneum.
2. Testis is made up of a mass of coiled seminiferous tubules.
3. Seminiferous tubules held together by connective tissue that contains blood vessels, lymph vessels, muscle fibre and interstitial cells.
4. Interstitial cells (Leydig's cells) produce the hormone called testosterone.
5. Seminiferous tubules are separated from one another by intertubular tissue.

T.S of Ovary of a mammal:

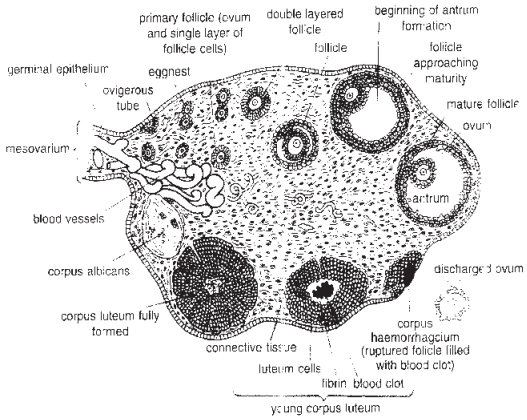

Fig 6.8 T.S of Ovary of Mammal

Comments:

1. Outer layer is of peritoneum made up of cubical cells.
2. Ovary is lined up by germinal epithelium which is bound by connective tissue tunica albuginea.
3. It consists of mass of connective tissue fibre and spindle shaped cells forming the stroma.
4. Stroma is differentiated into outer cortex and inner medulla.
5. Ovarian follicles, corpora lutea, corpora albicans and interstitial cells are lying in the cortex.
6. Medulla contains only blood vessels.

V.L.S of anterior lobe of pituitary gland of mammal:

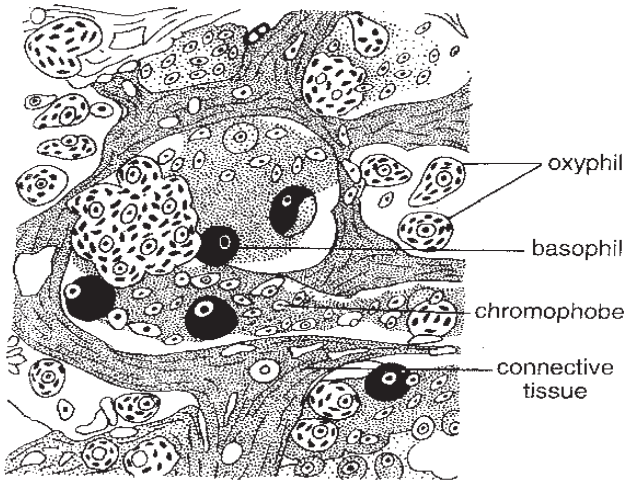

Fig 6.9 V.L.S of anterior lobe of pituitary gland of mammal

Comments:

1. Pituitary gland is an endocrine gland.
2. Pituitary gland is made up of three lobe namely anterior lobe, intermediate lobe and posterior lobe.
3. Anterior lobe forms the largest part of pituitary gland.
4. Anterior lobe is made up of three type of cells namely basophil, oxyphil and chromophobe .
5. Anterior lobe is responsible for producing many hormones like somatotrophic, thyrotropic,adrenocorticotrophic and gonadotrophic.
6. These hormones are responsible to control growth and development of sex glands.
7. Intermediate lobe is composed of cell cords with colloid filled follicles.
8. Posterior lobe is responsible for, vasopressin and oxytocin hormones.

T.S of thyroid gland of mammal:

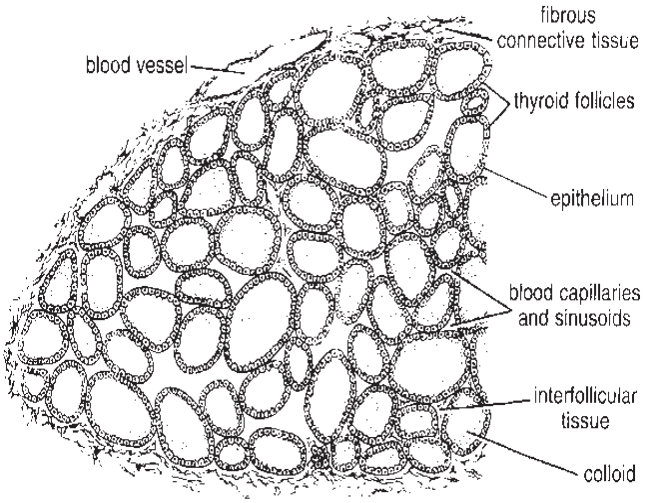

Fig 6.10 T.S of Thyroid gland of mammal

Comments

1. Thyroid is endocrine gland.
2. It is found on the ventro-lateral surface of larynx and posterior portion of trachea.
3. It is composed of two lobe connected by isthmus.
4. It consists of an outer fibrous capsule and number of rounded, oval or oblong thyroid follicles separated by inter-follicular tissue.
5. Each thyroid follicle is lined with simple cuboidal epithelium.
6. Cells of cuboidal epithelium contains large nuclei.
7. Thyroid gland is responsible for release of thyroxine hormone.
8. Thyroxine controls the entire metabolism.

6.5 STUDY OF THE SKELETON OF RABBIT

Axial Skeleton- Skull:

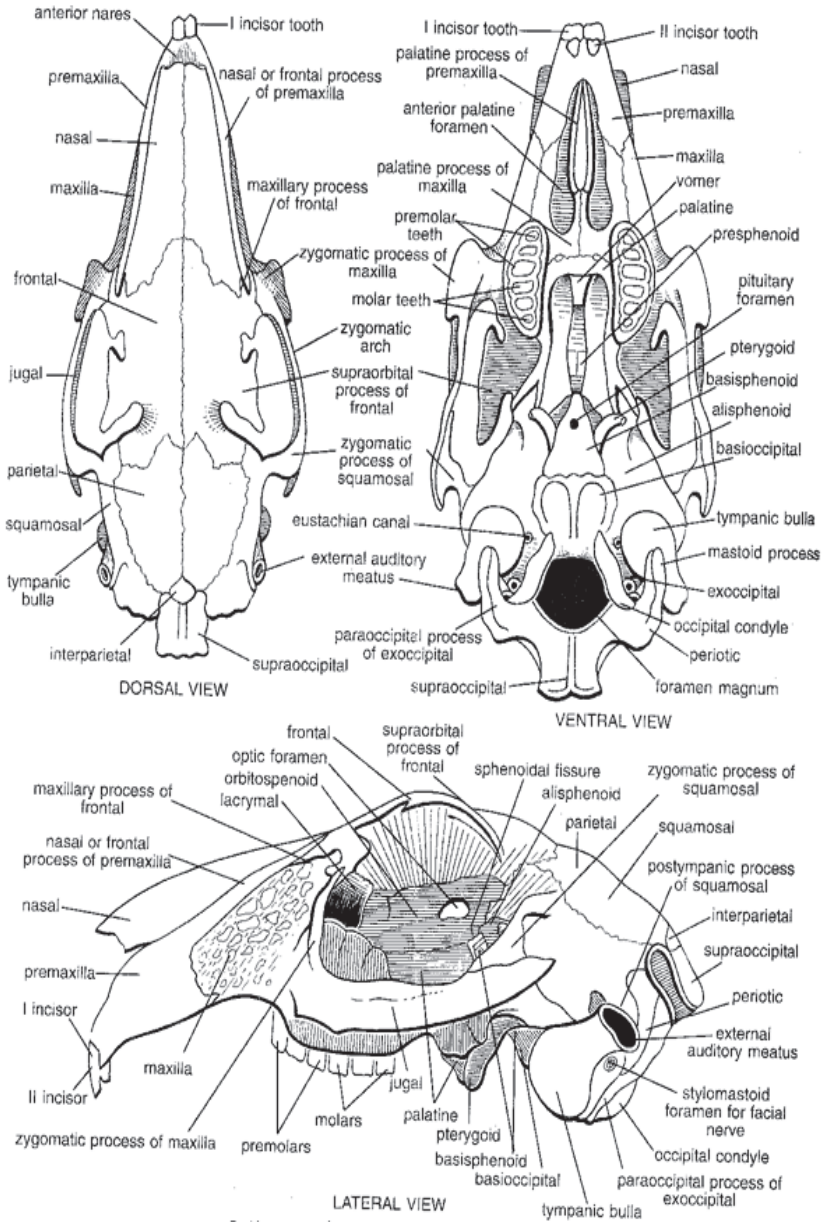

Fig 6.11 Skull of rabbit

Comments:

1. Completely Ossified with distinct sutures.

2. Dicondyle skull
3. Facial portion is elongated while cranial portion is small deflected at an angle of 60 degree.
4. Occipital region composed of four bones
   a) Two Lateral Exoccipital
   b) One Ventral Basioccipital
   c) Dorsal Supraoccipital
5. Auditory region composed of Periotic bone and tympanic bulla.
6. Each half of the lower jaw consist of a single bone- the dentary.
7. Teeth are heterodont and thecodont.

Disatriculated Bone:

1. Occipital segment:

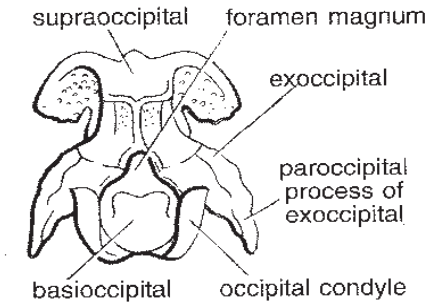

Fig 6.12 Occipital segment of Rabbit

1. It is the most posterior part of the skull having a large foramen magnum.
2. It consists of 4 bones
   a)lateral exocciptels- (Two)
   b) ventral basio occipital –(One)
   c) dorsal supraoccipital – (One)

2. Basisphenoid and Alisphenoid

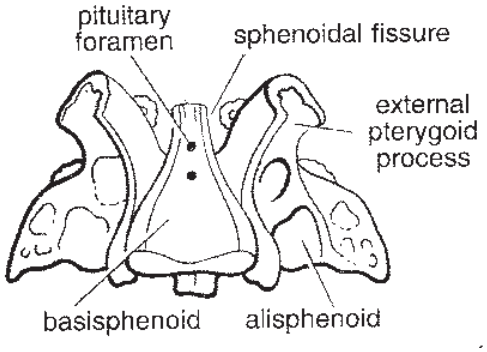

Fig 6.13 Basisphenoid and Alisphenoid of Rabbit

1. It is a compound bone of parietal region of skull.
2. It is a median triangular bone present in front of basioccipital and united to a thin plate of cartilage with its broad base.
3. Alisphenoid are a pair of wing like bone obliquely attached to the sides of basisphenoid.
4. At the anterior end between alisphenoids and basisphenoid a sphenoidal fissure is present for the passage of 3^{rd} ,4^{th}& 6^{th} nerves.

3. Parietal:

Fig 6.14 Parietal of rabbit

1. It is a rectangular membrane like thin bone.
2. It lies in the parietal region of skull along the roof of cranial cavity.
3. At the posterior end it forms a plate like ventral process.

4. It articulates at anterior with frontal, laterally with squamosal & posteriorly with inter-parietal.

4. Presphenoid and Orbitosphenoid:

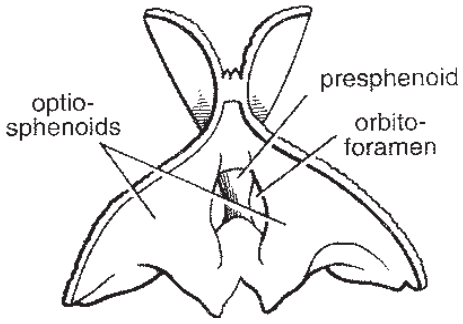

Fig 6.15 Presphenoid and orbitosphenoid of rabbit.

1. It is a compound bone present in frontal region of skull.
2. Presphenoid is laterally compresed bone forming the floor of frontal region of cramium.
3. Orbitosphenoid are paired wing like thin bones attached on either side of presphenoids.
4. Orbitosphenoid forms the frontal region of cranium.

5. Frontal:

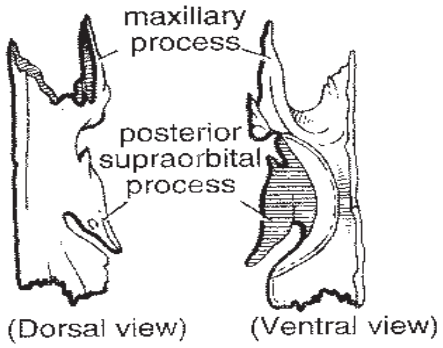

Fig 6.16 Frontal of rabbit

1. These are paired membranous bones.

2. Frontals form the roof of sides of anterior part of cranial cavity.
3. It articulates at anterior with the nasal at posterior with parietal &at ventral with orbitosphenoid.

6. Nasal:

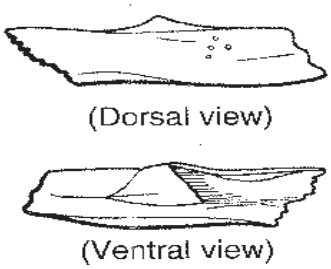

Fig 6.17 Nasal bone of rabbit

1. Nasals are paired thin bones of olfactory region of skull.
2. It articulates anteriorly with premaxilla and posteriorly with frontal.

7. Periotic and Tympanic bulla:

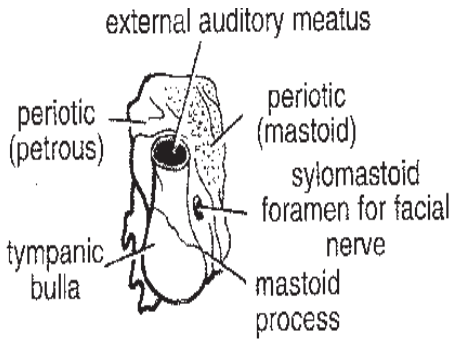

Fig 6.18 Periotic and Tympanic bulla of rabbit.

1. It is a compound bone of auditory capsule of skull.
2. Periotic is perforated cartilage bone. It is divided into petrous (hard) portion and mastoid(porous) region.
3. Tympanic is a flask shaped bone attached on the outer side of periotic.

4. Its lower swollen part is called tympanic bulla which encloses tympanic cavity.
5. Tympanic cavity encloses 3 auditory ossicles- mallous, incus & stapes.

8. Squamosal:

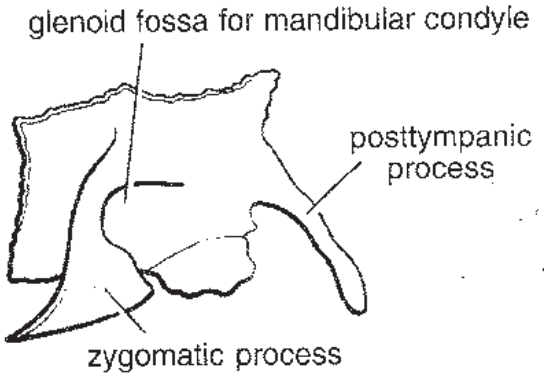

Fig 6.19 Squamosal bone of rabbit

1. It is arectangular plate like bone.
2. It is present ventral to parietal.
3. It gives rise to post-tympanic process and a zygomatic process.
4. It articulates at anterior with frontal and jugal, laterally with parietal and posteriorly with supraoccipital.

9. Premaxilla:

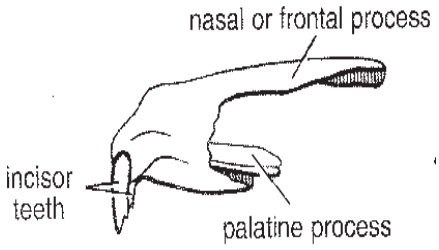

Fig 6.20 Premaxilla bone of rabbit

1. Premaxilla is a triangular bone of upper jaw.
2. It bears 2 socket along its anterior end for incisor teeth.

10. Maxilla:

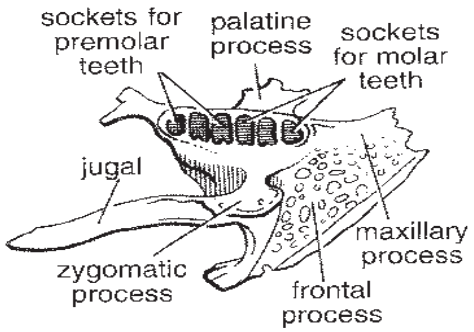

Fig 6.21 Maxilla bone of rabbit

1. Maxilla forms the major part of upper jaw and the sides of face.
2. It bears sockets for premolar and molar teeth.
3. It articulates anteriorly with premaxilla, posteriorly with palatine & dorsally with nasal & frontal.

11. Lower jaw(Mandible)

1. Lower jaw consists of two rami, dentaries meeting in front by a suture.
2. Dentraries are flattened plate like.
3. Each dentary bears sockets for incisors at anterior end, premolars and molars at the posterior end.
4. The posterior end of each dentary poses a condyle and coronoid process at upper surface and an angular process at lower surface.
5. The condyle articulates with the glenoid fossa of squamosal bone.

Vertebral Column:

1. Atlas Vertebra:

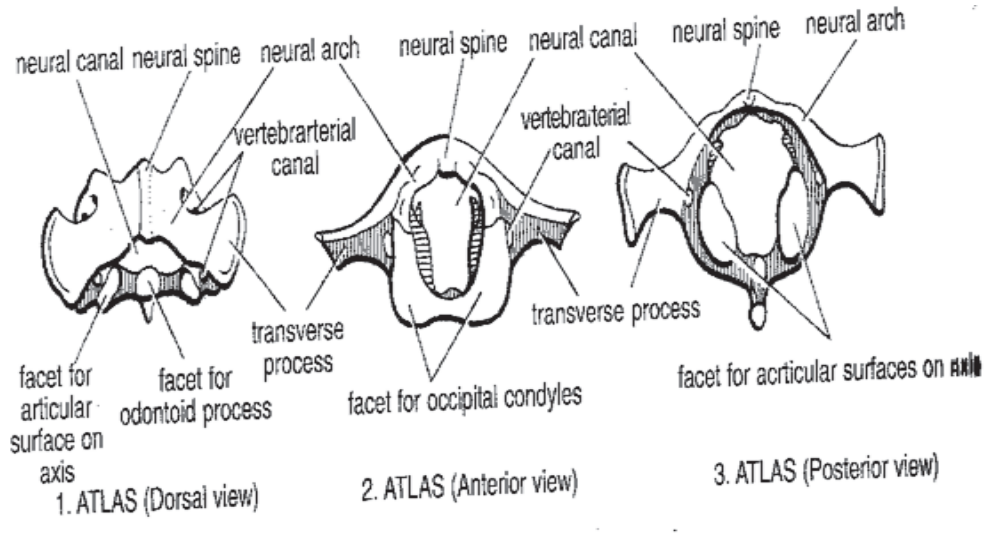

Fig 6.22 Atlas vertebra of rabbit

1. Atlas is the first cervical ring like vertebra.
2. It possess ridge like poorly developed neural spine.
3. Broad horizontal plate like transverse processes is present.
4. A small opening called vertebrarterial canal is present at the base of each transverse process.
5. Two concavities for occipital condyle of the skull are present at the anterior side.
6. Single facet for odontoid process of axis vertebra is present on posterior side.

2. Axis Vertebra:

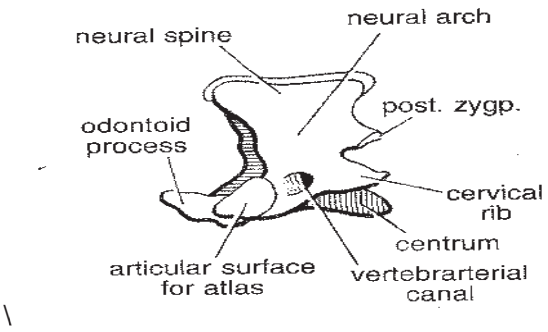

Fig 6.23 Axis vertebrae of rabbit

1. Axis is the second cervical vertebra.
2. Neural spine is well developed and laterally compressed.
3. Transverse processes are absent.
4. Postzygapophhyse are present while prezygapophyses are absent.
5. Small cervical ribs are perforated by vertebrarterial canals.

3. Typical Cervical Vertebra:

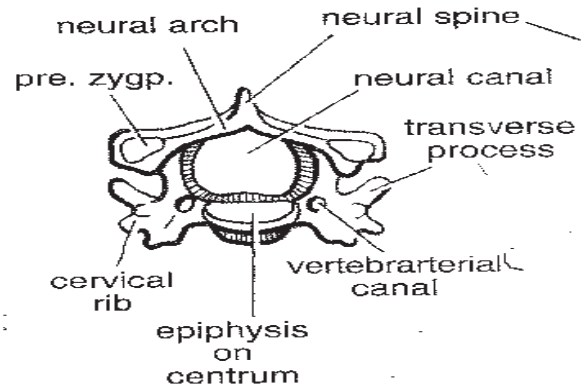

Fig 6.24 Typical Cervical Vertebra of rabbit

1. There are five cervical vertebrae (3-7) similar in structure. Therefore called as typical cervical vertebrae.
2. Centrum is acoelous.
3. Neural Spine is small and backwardly directed.
4. Pre and post zygapopyses are present.

4. Anterior Thoracic Vertebra:

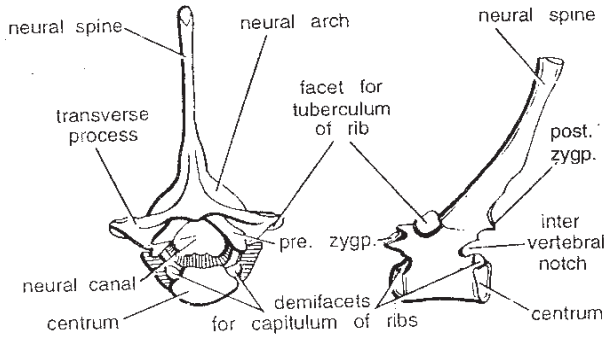

Fig 6.25 Anterior Thoracic Vertebra of rabbit

1. Short acoelous centrum.
2. Transverse process are short, stout & horizontal.
3. Neural spine is very long, slender & backwardly directed.
4. Pre and post zygapopyses are present.

5. Posterior Thoracic Vertebra:

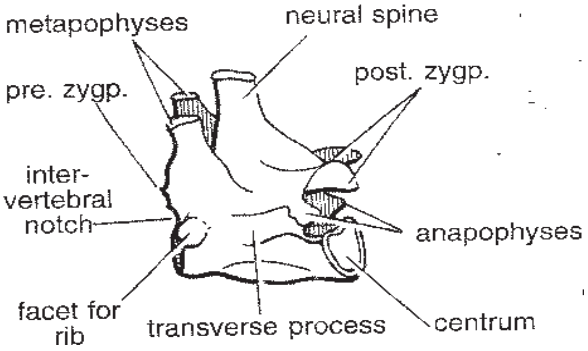

Fig 6.26 Posterior Thoracic Vertebra of rabbit

1. Large and acoelous centrum.
2. Small, vertical and compressed neural spine.
3. Pre and post zygapopyses are present.
4. Metapophyses are present above the prezygapophyses.
5. Anapophyses are present below the postzygapophyses

6. Anterior Lumbar Vertebra:

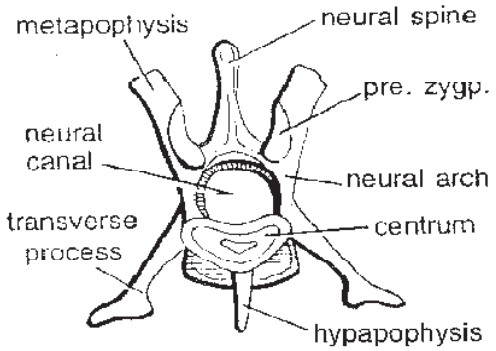

Fig 6.27 Anterior Lumbar Vertebra of rabbit

1. It is comparatively larger in size.
2. Well developed acoelous centrum.
3. Neural arch is surrounded by neural spine.
4. Pre and post zygapopyses are present.
5. Metapophyses is present above prezygapophyses at the anterior end.
6. Anapophyses is present below postzygapophses.
7. Hypapophyses is also present.

7. Posterior Lumbar Vertebra:

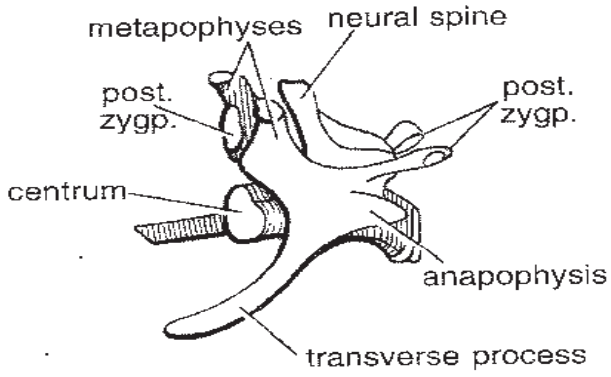

Fig 6.28 Posterior Lumbar Vertebra of rabbit

1. Posterior lumbar vertebra is similar to anterior vertebra except the absence of hypapophysis.

8. Sacrum:

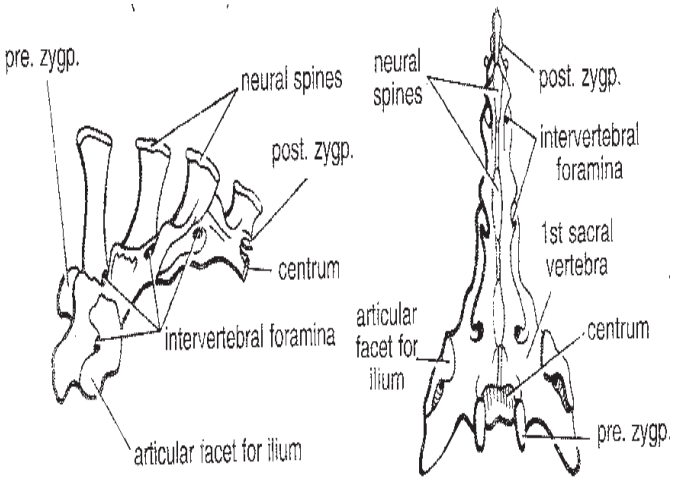

Fig 6.29 Sacrum bone of rabbit.

1. Sacrum is formed by fusion of 4 sacral vertebrae.
2. It support pelvic girdle.
3. It has backwardly directed neural spines.
4. Centrum is acoelous or flat.
5. Pre and post zygapopyses are present.

9. Caudal:

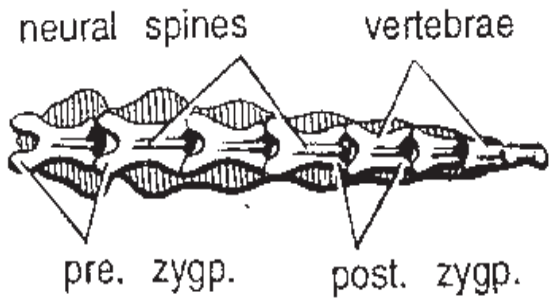

Fig 6.30 Caudal Bone of rabbit

1. There are 16 caudal vertebrae .
2. Size decrease as we move backwards.

10. Rib:

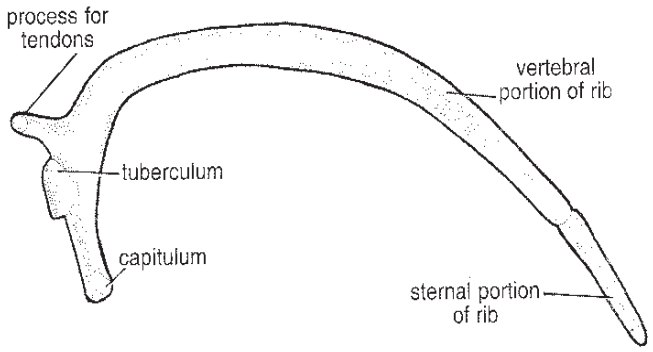

Fig 6.31 Rib Bone of rabbit

1. Rib consists of a vertebral and Sternum portion.
2. Vertebral is bony and possess two processes i.e tuberculum and capitulum.
3. Sternal portion is cartilaginous and articulates with sternum.
4. Uncinate process is absent.

11. Sternum:

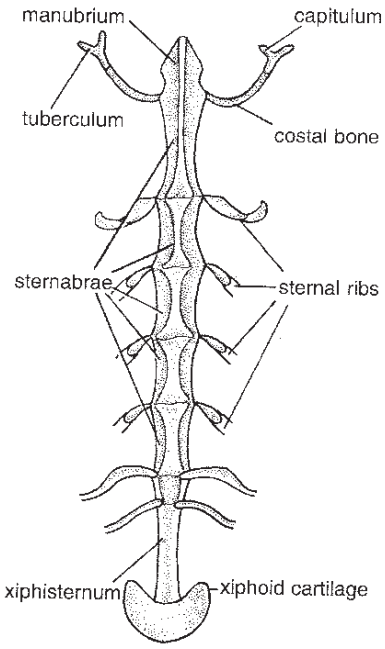

Fig 6.32 Sternum of rabbit

1. Sternum is made up of 6 rod like pieces called Slernabrae.
2. First piece is called manubrium.
3. Last piece is called Xiphisternum.
4. Xiphisternum forms an expanded plate called Xiphisternal cartilage or Xiphoid cartilage.

Appendicular Skeleton

1. Pectoral Girdle:

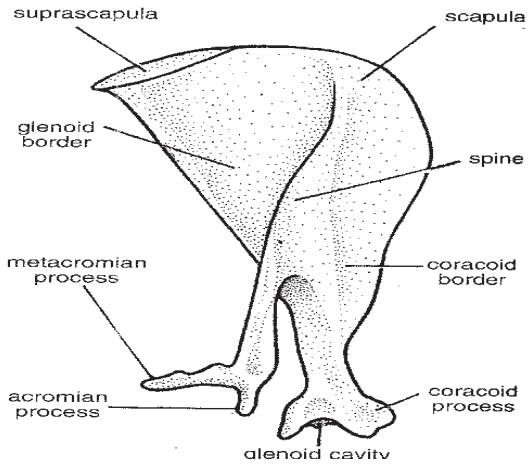

Fig 6.33 Pectoral Girdle of rabbit

1.Pectoral girdle is present as 2 separate halves due to presence of thoracic ribs.

2. It consists of clavicle and scapula-coracoid

I. **Scapula-coracoid:** It is a triangular portion having glenoid cavity for the head of humerous. Over glenoid cavity hangs a coracoid process. A distinct vertical spine divides outer surface of scapula and it terminates below into an acromian process(directed inwards) , which further gives posteriorly a metacromian process(backwardly).

II. **Clavicle :**A slender curved bone articulates between manubrium of sternum at one end with acromian process of scapula on other end. .

2. Pelvic Girdle:

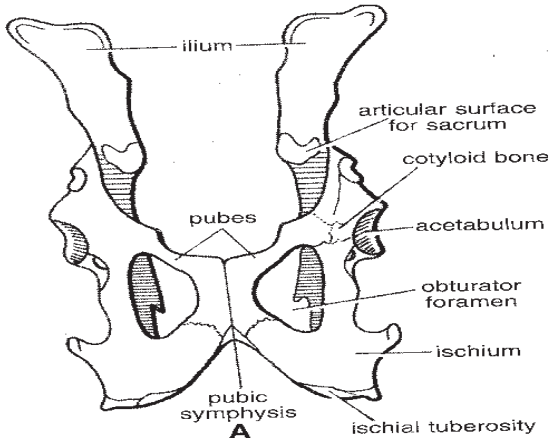

Fig 6.34 Pelvic Girdle of rabbit

1. Pelvic girdle is composed of 2 equal halves called os-innominata.
2. Os-innominata are united at public symphysis .
3. Each innominatum consists of 3 pieces:
   I. **Ilium:** it is a blade like bone present parallel to vertebral column.
   II. **Ischium:** It is stout and straight bone present opposite to Ilium.
   III. **Pubis:** It is smallest bone among the three. It becomes transverse near the acetabulum.
4. Acetabulum is present at the union of ilium and ischium.
5. A cavity called obturator foramen is present between pubis and ischium.

3. ForeLimbs Bones:

1. Humerus:

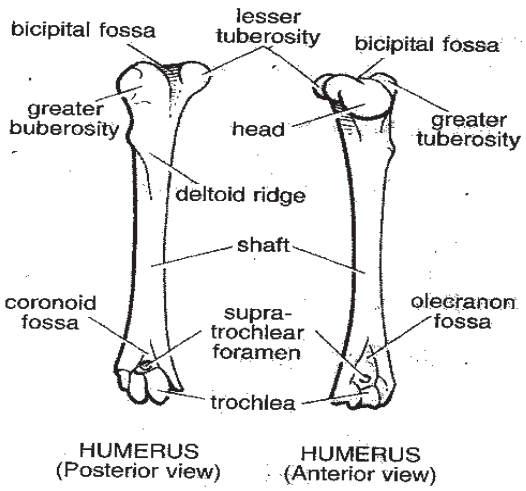

Fig 6.35 Humerus Bone of rabbit

1. It is the bone of upper arm(fore –limb).
2. Its proximal end forms a rounded head which fits into glenoid cavity of pectoral girdle.
3. Its distal end bears pulley like trochlea for articulation and olecranon fossa.
4. Distally it articulates with radius and ulna.

2. Radius and Ulna:

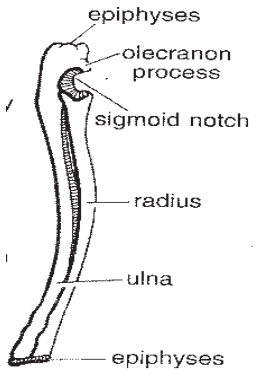

Fig 6.36 Radius and Ulna bone of rabbit

1.Radius and ulna are the bones of fore arm.

2.Radius is small and slightly curved bone.

3. Ulna is longer than radius.

4.Radius articulates with trochlea of humerus proximally and with the bone of wrist distally.

5.Proximally ulna continues into the olecranon process and a sigmoid notch which articulates with trochlea of humerus.

6. Distally ulna and radius articulates with carpals.

3. **Hand bone**

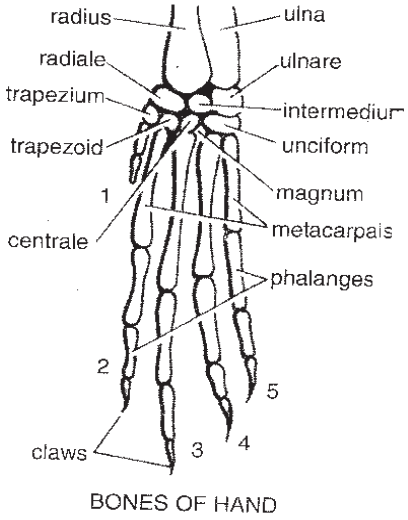

Fig 6.37 Hand bone of rabbit

1. Hand contains 9 small bones arranged in two rows namely proximal and distal row .

2.Proximal row contains radiale, intermedium and ulnare.

3. Distal row contains single central, trapezium, trapezoid, magnum and unciform.

4. Pisciform a sesamoid bone is present on the ventral side.

5. There are 5 digits with varying number of phalanges.

4. Hind Limbs Bones:

1. Femur:

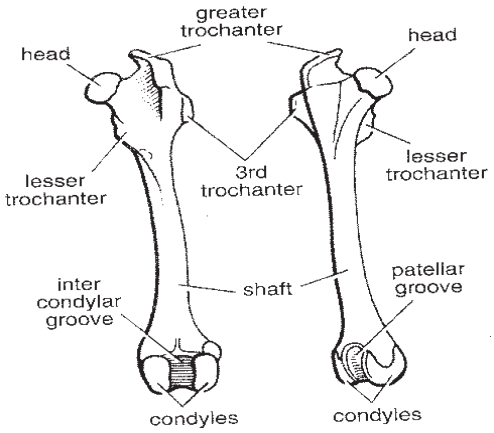

Fig 6.38 Femur bone of rabbit

1.Femur is the thigh bone and stoutest bone.

2.The proximal end bears rounded head which fits into acetabulum of pelvic girdle.

3. Proximal end beans three projections i.e great trochanter, third trochanter and lesser trochanter.

4. Distal end bears 2 large condyles. These condoyle articulate with tibia.

2. Tibio-fibula:

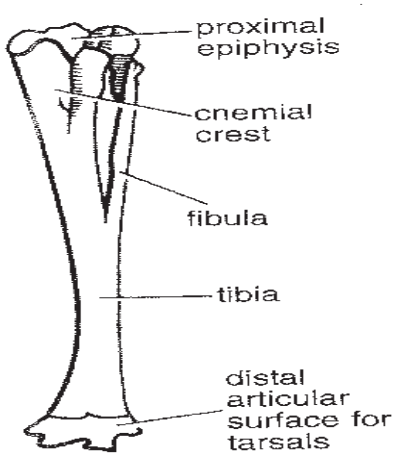

Fig 6.39 Tibio-fibula bone of rabbit.

1. Tibio-fibula is the shank of hind limb.
2. Tibia is straight and stout bone.
3. The proximal end of tibia articulates with condyles of femur and distal end articulates with tarsal bone.
4. Fibula is a straight bone fused distally with tibia.

3.Foot Bone:

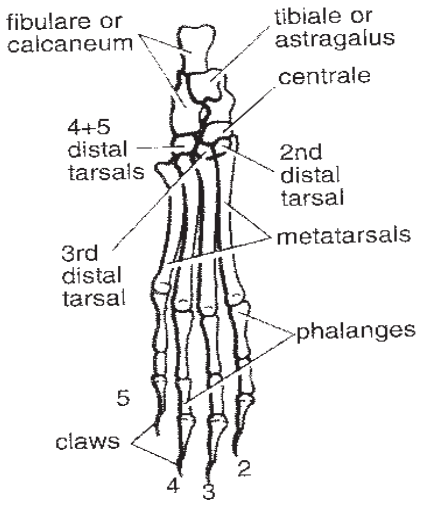

Fig 6.40 Foot Bone of Rabbit

1. It contains 6 tarsal bones arranged in two rows.
2. Proximal row has astragalus (fusion of tibiale and intermedium) on inner side and calcaneum on the outer side.
3. Distal row contains four bones – mesocuneiform, ectocuneiform, centrale and cuboid.

6.6 STUDY OF THE MUSEUM SPECIMEN

6.6.1 (a) *Tachyglossus*

General Characteristics:

1. *Echidna* is commonly known as spiny ant-eater.
2. Body is divided into head, neck and trunk.
3. Skin is covered with strong pointed spines with underground layers of hairs.
4. Head has a tubular snout.
5. Eye are small and external ear or pinna is absent.
6. Claws are long and strong used for tearing down Ant-hills or Termite nest.

7. Tongue is extremely long and protrusible covered with a sticky salivary secreation and posterior portion of tongue is used for grinding insects because of having saw like teeth.
8. Noctural and lives in burrows.
9. They are found in New Zealand,Tasmania and New Guinea.

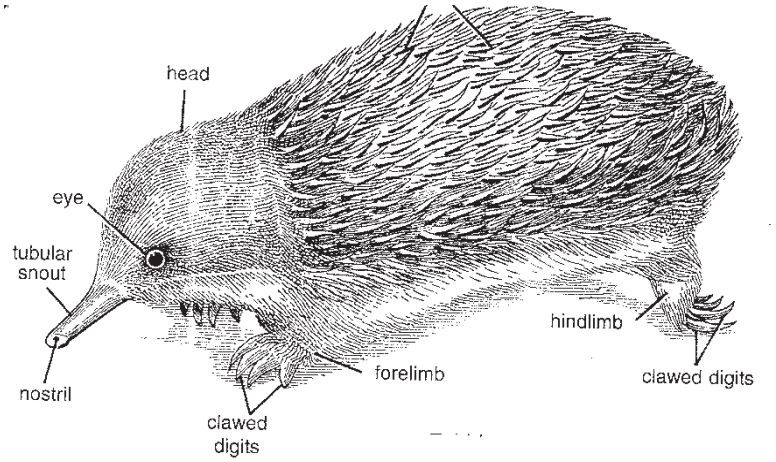

Fig 6.41*Echidna*

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.

Class : Mammalia ->Warm Blooded, Mammary glands present;, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.

Sub class : Prototheria ->Mammary glands without nipples,egg laying mammals.

Order : Monotremata ->cloaca present.

Genus : *Echidna*

Species :*aculeata*

6.6.1 (b) Ornithorhynchus

General Characteristics:

1. They are commonly called as Duck Billed Platypus.
2. Its length is about 45-50 c.m having short fur dark brown color and combine the characters of a duck with a mammals.
3. Body is divided into head, trunk and tail.
4. It is connective link between reptiles and mammals with few characteristics of a duck.
5. Limbs are short and five toed.
6. Teeth are absent in adult.
7. They are found in eastern and southern part of Australia and Tasmania.

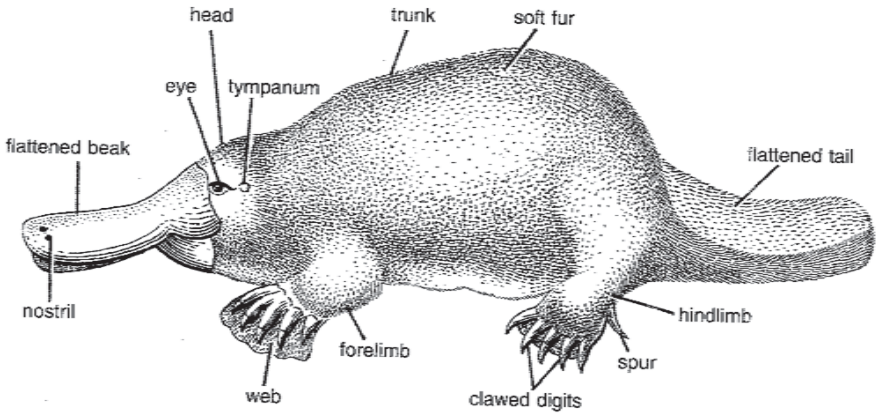

Fig 6.42Ornithorhynchus(Platypus)

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; two pairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.

Class : Mammalia ->Warm Blooded, Mammary glands present, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.

Sub class : Prototheria ->Mammary glands without nipples, egg laying mammals.

Order : Monotremata ->cloaca present.

Genus : *Orinthorhynchus*

Species :*anatinus*

6.6.2 (a) Pangolin

General Characteristics:

1. They are commonly called as Scaly Ant Eater.
2. Body length is of 90 cm.
3. Body is covered with thick horny scales.
4. Body is divided into head, neck, trunk and tail.
5. Eyes are small, Teeth absent and ear is reduced.
6. Limbs are short, Fore Limbs have strong curved claws.
7. Noctural.
8. Pyloric stomach works like gizzard of birds, having small pebbles or stones in it.

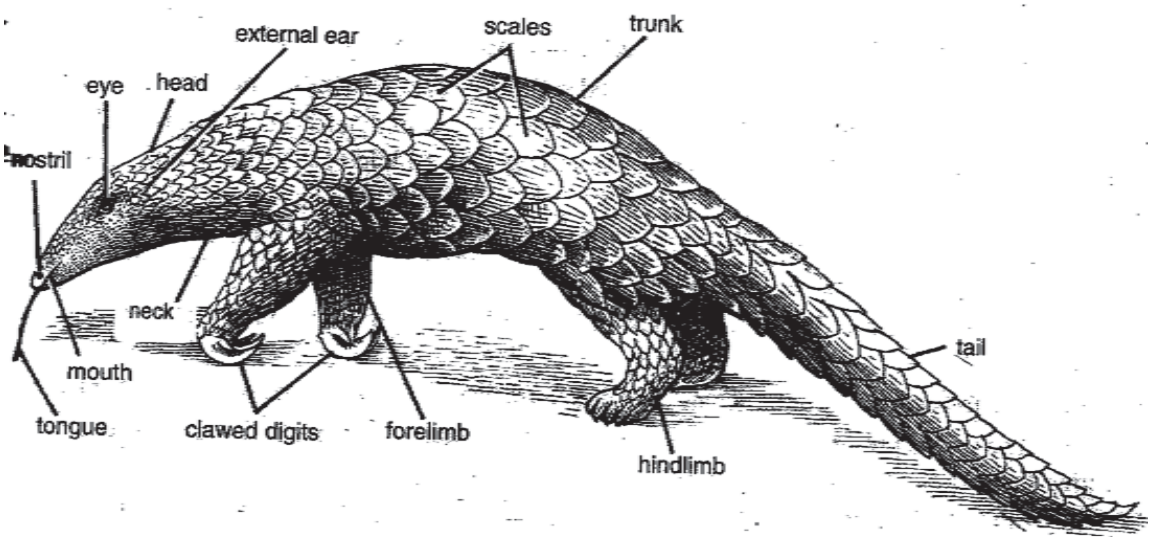

Fig 6.43 Pangolin

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.

Class : Mammalia ->Warm Blooded, Mammary glandspresent, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.

Sub class : Theria ->Mammary glands with nipples, Placental mammals.

Infra class : Eutheria -> Marsupial pouch absent, cloaca absent

Order : Pholidota---Horny scales on body, Snout is elongated, Tongue is long,sticky and protrusible.

Genus : *Manis*

Species :*crassicaudata*

6.6.2 (b) Funambulus

General Characteristics:

1. *Funambulus* is commonly knowns as Squirrel or Gilhari.
2. Body is elongated covered with fur, and contains 3 white or grey stripes on its dorsal surface.
3. Body is divided into head, neck, trunk, chest, abdomen and tail.
4. Head contain snout with moustaches, nostrils, large eyes and large ears.
5. They are arboreal and active climber found all over the world.
6. Fore limbs and hind limbs are well developed.

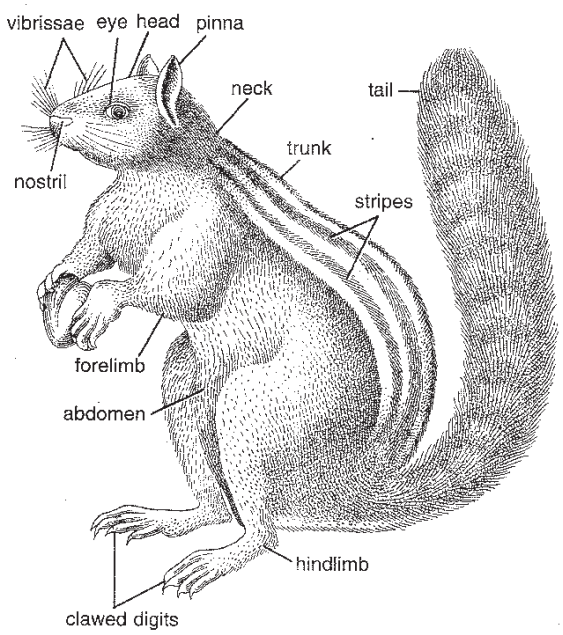

Fig 6.44Funambulus

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.
Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C
Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.
Class : Mammalia ->Warm Blooded, Mammary glands present, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.
Sub class : Theria ->Mammary glands with nipples, Placental mammals.
Infra class : Eutheria -> Marsupial pouch absent, cloaca absent
Order : Rodentia --- One pair of Upper Incisors, Limbs with five toes and claws.
Genus : *Funambulus*
Species :*palmarum*

6.6.3 (a) *Pteropus*

General Characteristics:

1. *Pteropus* is commonly known as Flying fox or Chamgadar.
2. Body length is of 30 cm with nearly 1.5 meters of wings span.
3. Body is of dark brown color covered with fur , divided into head, neck, trunk, tail and patagium.
4. Snout is long and face is of fox.
5. Tail is small in size.
6. Forelimbs are modified into wings formed by a fold of skin(patagium), hind limb contain sharp & curved clawed digits and they also included in patagium.
7. They have highly developed sonars. Nocturnal
8. They are found in India,Sri Lanka, Africa, Australia.

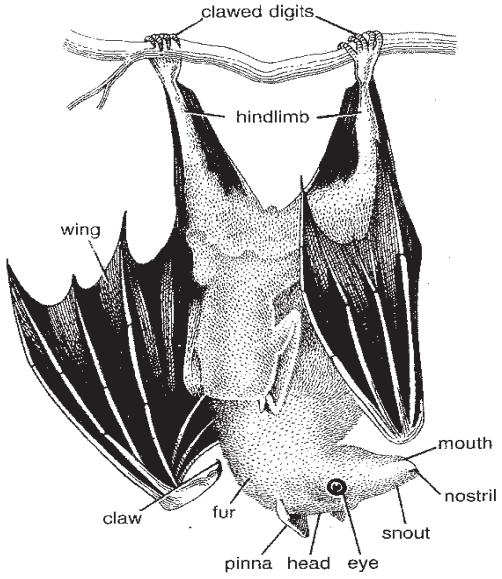

Fig 6.45 Pteropus

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.

Class : Mammalia ->Warm Blooded, Mammary glands present, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.

Sub class : Theria ->Mammary glands with nipples, Placental mammals.

Infra class : Eutheria -> Marsupial pouch absent, cloaca absent

Order : Chiroptera --- Large Fruit eating bats, Fore limbs are modified for flight, Hind limbs are weak, Vision is weak.

Genus : *Pteropus*

Species :*giganteus*

6.6.3 (b) *Loris*

General Characteristics:

1. Body is covered with brownish wooly fur with silvery look.
2. Body is divided into head, trunk, abdomen and tail.
3. Head is fox like having pointed snout and bulging eyes.
4. Teeth thecodent or heterodont and 36 in number.
5. Tail long.
6. Limbs elongated with flat nails digits.
7. They are found in India.
8. They show few characteristics of higher primites.

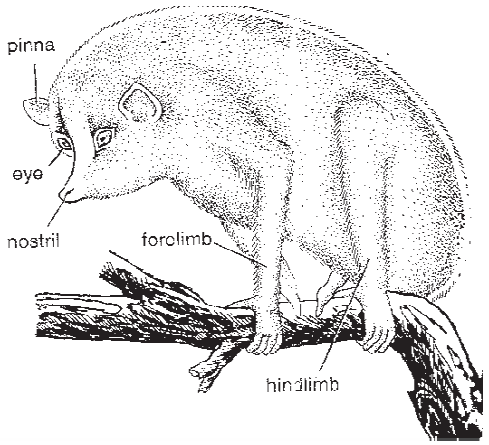

Fig 6.46 Loris

Systematic Position:

Phylum : Chordata -> Dorsal tubular nerve cord, notochord and paired gill-slits are present.

Group : Craniata ->Definite head and cranium with brain.

Subphylum: Vertebrata ->Notochord is replaced by vertebral column; twopairs of appendages; circulatory system closed , blood is red in color containing R.B.C

Division : Gnathostomata->Jaws and paired appendages are present

Superclass : Tetrapoda ->Paired limbs, lungs, and bony skeleton.

Class : Mammalia ->Warm Blooded, Mammary glands present, teeth heterodont,thecodont and diphyodont,skull with two occipital condyles, heart four chambered, R.B.C non nucleated, kidneys metanephros.

Sub class : Theria ->Mammary glands with nipples, Placental mammals.

Infra class : Eutheria -> Marsupial pouch absent, cloaca absent

Order : Primates --- Hands and feet are more or less prehensile, Mode of living is Plantigrade.

Genus : *Loris*

Species :*lydekkerianus*

6.7 GLOSSARY

Acromion: Prolongation of the spine of the scapula forming point of the shoulder.

Arboreal: Lives in trees or bushes.

Bunodont: Having molar teeth with crowns in form of rounded or conical cusps**.**

Clavicle: Collar bone in man or its homologus in other vertebrates.

Cloaca: A chamber that opens through the anus that is used for both excretion and reproduction.

Corpus callosum: Tract of transverse nerve fibres in mammals, uniting the cerebral hemispheres of brain

Cranial: Often referring to the top of the head.

Dicondylic: Skull which contains double occipital condyle**.**

Dorsal: Pertains to the back or upper surface.

Epiphyses: End of long bone**.**

Epipubic:pair of bones in front of pubis of marsupials.

Endocrine: Glands that release its secretion directly.

Endothermic: An animal that regulates its own body temperature.

Exocrine: Glands that releases its secretion through ducts.

Heterodont: Having different types of teeth.

Lateral: Pertaining to the side.

Lophodont: Having molar teeth with crowns in form of transverse ridges.

Noctural: Active at night**.**

Patagium: Folds of skin connecting the forelimb and hindlimb.

Posterior: Pertaining to the rear.

Plantigrade: Walking with the whole sole of foot bearing on the ground.

Prehensile tail: Capable of grasping or wrapping with the tail.

Proboscis: Tubular extension of the nose,lips or pharynx.

Protrusible:A body part capable of being extended.

Sacculated: Portion of membranous labyrinth of the internal ear**.**

Sebaceous glands: Skin glands found in connection with hair follicles of the mammals.

Selenodont: Molar teeth having crescent shaped ridges on the grinding surface.

Quadrepls: Four Footed animals

Terrestrial: Lives on the land.

Thorax: A division of an animal's body that lies between the head and the abdomen.

Tympanum: The external eardrum.

Ventral: Pertaining to the underside, the lower surface.

Zygapophysis: One of the four projection,two anterior and two posterior, extending from the neural arch of a vertebra.

6.8 SELF ASSESMENT QUESTION

1. Study of mammals is called:
   Myology b) Malacology c)Mastology d) Mammology
2. Which one is regarded as connecting link between reptiles and mammals?
   Archaeopteryx b) Loris c) Dinosaurs d) Ornithorhynchus.

3. Primary character presents in mammals is the
   Regulation of body temperatureb) Viviparity
   Mammary gland d) Four chambered heart
4. National mammal of India is :
   Tiger b) Lion c) Elephant d) Cheetah.
5. Uterus and vagina are absent in:
   a) Elephants b) Echidna c) Kangaroos d) Armadillos
6. Skull is dicondylic in:
   a) Amphibians b) Reptiles and birds
   b) Aves and mammals d) Amphibians and mammals.
7. Milk having highest percentage of fat is that of:
   a) Elephants b)Cats c) Porpoises d) Rats
8. Prototherians are confined to:
   a) Sub Tropical Region b) Ethiopian Region
   b) Australian Region d) Tropical Region
9. Epipubic bone is found in
   a) Rats b) Kangaroos c) Kangaroo rats d) Platypus .
10. Uterine gestation is absent in:
    a) Wombats b) Marsupial moles c) Spiny Anteaters d) Giant anteaters
11. Only poisonous mammal is:
    a. a) Sloth b) Duck billed platypus c) Hedgehog d) Echidna
12. Sonar and radar system is found in:
    a) Whales b) Pangolin c)*Pteropus* d) Elephants

Answer:

1(d) 2(d) 3(c) 4(a) 5(b) 6(d) 7(c) 8(c) 9(b) 10(c) 11(b) 12 (c)

6.9 TERMINAL QUESTION / ANSWER

1. Why monotremes and marsupials are not considered as true mammals
    a. They are different reproductive patterns. Monotreme lays egg while marsupials give birth to immature young ones.
2. Why Stomach of monotremes is not considered as true stomach?
    a. Stomach lacks glands at the lining of epithelium.
3. Why Cetaceans need to come on the water surface?
    a. They come to surface to exhale carbon dioxide and inhale oxygen.

6.10 REFERENCES

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UNIT 7 ECOLOGICAL & ENVIRONMENTAL EXPERIMENT

CONTENTS

7.1 OBJECTIVES

By the end of this chapter, you should know

1. How to calculate pH of water and soil
2. How to calculate dissolved oxygen and carbon dioxide in water sample.
3. Adaptions study by animals in different ecological environment.
4. Study of wild animals
5. Study of rare and endangered faunal species of uttrakhand state.

7.2 INTRODUCTION

Environmental Biology is the study of the natural world, as a whole or in a particular area, especially as affected by human activity. The Environmental biologists study the habitats, evolution and adaptations of living organisms. This interdisciplinary field of environmental biology focuses on the relationships among plants, animals and their surroundings, including their responses to environmental stimuli. It is closely linked to and often coupled with evolutionary biology, since both involve an exploration of how organisms adapt to changing conditions.

7.3 ESTIMATION OF PH OF WATER/SOIL SAMPLE

pH is a numerical scale to specify the acidity or alkalinity of an aqueous solution. It is the negative of the base 10 logarithm of molar concentration, measured in units of moles per litre of hydrogen ions.Solution is acidic when pH varies from 0 to 7 (more precisely 6.9) and basic when it varies from 7(more precisely 7.1 to 14. When pH is 7 solution is referred to as neutral.

7.3.1 Steps to measure pH of water

Step 1: Calibrate pH meter following manufactures manual.

Step 2: Clean electrode with distill water.

Step 3: Dry electrode using tissue paper

Step 4: Dip the electrode in sample water.

Step 5: Note the reading.

7.3.2 Steps to measure pH of soil

Step 1: Calibrated pH meter using pH buffer solution.

Step 2: Meter is adjusted with known pH of buffer solution 4.0 and 9.2.

Step 3: 20 gram of sample soil is weighted and transferred to 100 ml beaker .

Step 4: 40 ml distilled water is added to beaker containing sample soil.

Step 5: A glass rod is used to stir soil with water.

Step 6: After stirring leave the sample for 30 mts with intermittent stirring.

Step 7: electrodes are immersed into the beaker. pH value is determined from the reading of automatic pH meter.

7.4 DETERMINATION OF DISSOLVED OXYGEN AND CARBON DIOXIDE IN WATER SAMPLE

1. Determination of dissolved oxygen:

Dissolved oxygen is the level of free non-compound oxygen present in water or aqueous solution. Dissolved oxygen is a basic parameter to access the quality of water. It is used by living organism like fish, invertebrates, bacteria and plants residing in water for respiration.

Methods to calculated Dissolved Oxygen:

The most commonly used method to calculate dissolved oxygen is**Winkler's iodometric** method.

Step 1: Take sample in 300ml capacity BOD bottles.

Step 2: pour 2 ml of MnSo4 and strong alkaline solution. Note: reagents should be poured at the bottom from the wall. Solution will be of dark blue color.

Step 3: Mix thoroughly.

Step 4: A white precipitate will appear.

Step 5: Keep the bottle to settle precipitate.

Step 6: Add 1-2 ml of conc. H2SO4 and shake well. This will dissolve the precipitate.

Step 7: Take a sample in a conical flask.

Step 8: Titrate the sample with sodium thiosulphate solution using starch as indicator.

Step 9: Color will change from Dark blue color to colourless.

Calculation:

DO mg/l = (ml *N of titrant) * 1000 * 8/ V2*(V1-V) / V1

Where

V= Volume of MnSO4 and alkaline solution added.
V1= Total volume of sample in bottle.
V2= Volume of sample titrated.

2. Determination of dissolved carbon dioxide :

Dissolved carbon dioxide is the level of free non-compound carbon dioxide present in water or aqueous solution. Aquatic plants depends upon carbon dioxide and bicarbonates(form with reaction of CO_2 with water) for growth.

Methods to calculated Dissolved Carbon Dioxide:

The most commonly used method to calculate dissolved carbon dioxide is :

Step 1: Take 50 -100 ml sample in a conical flask.
Step 2: Add few drop of phenolphthalein indicator.
Step 3: If Color turns pink, then free CO2 is absent.
Step 4: If color remain colorless.
Step 5: Titrate it with 0.05N NaOH
Step 6: Solution will turn into pink .

Calculations:

Free CO_2 mg/l = (ml * N of titrant) * 1000 * 44/ ml of sample taken.

7.5 STUDY OF ADAPTATIONS IN ANIMLS INHABITING DIFFERENT ECOLOGICAL ENVIRONMENTS

Ecology is a biological science in which we stud the relationships between living organisms and their environment. Environment keeps changing from one part of the globe to another. Flora and Fauna resides in one of these environments. They have to adapt to the changing environment for survive.

There are two basic environment .ie**Water and Land**.

7.5.1 WATER(HYDROCOLES)

This includes Marine and Freshwater ecosystem.The animals residing in water have to adjust their body with difference in osmotic pressure of external water medium and their body. To overcome it the list of adaptation are as follows:

1. Body is stream lined.
2. Presence of paired and unpaired fins.
3. Body muscles are arranged in the form of bundles separated by mycommata.
4. Respiration by Gills.
5. Presence of air-bladder filled with air.
6. Presence of lateral –line system.
7. Integument rich in mucous glands or protected with scales.

7.5.2 LAND(TERRESTRIAL CONDITION)

The animal living on land includes desert , grassland, forest ecosystem

1. **Desert Region:** The terrestrial animal living in desert region. These are driedest part of our earth. The following adaptation are as follows:
    1. Skin is quite hard.
    2. Large ear with blood veins and covered with hairs.
    3. Store fat in body.
    4. Majority of animal is nocturnal or crepuscular.

5. Less sweet glands.

2. **Grasslands Region:** Grasslands are defined as areas where there is too little rainfall to support a forest, but too much rainfall to classify the land as a dry ?? desert. The following adaptation are as follows:
    1. There skin have pattern to support camouflage.
    2. Big, broad teeth, equipped with flat tops.
    3. They are gregarious(Living in groups).
    4. Majority of animals are nocturnal.
3. **Arctic Region:** The terrestrial region residing in Polar areas. This region is marked by frezzing temperature . The following adaptation are as follows:
    1. Body is covered with Fur resulting in retaining heat.
    2. Hibernation.
    3. Trapped air insulator.
    4. Fat insulator.
    5. Oil coat keeps the wet away.

7.5.3 IN BOTH LAND AND WATER (AMPHIBIOUS CONDITION)

This sort of adaptation includes those who lives in both land and water. This is also refers to as Secondary Hydrocoles. The main adaptation are as follows:

1. Body stream-lined, neck constricts absent, tail elongated.

2.Shortened, body dorso- ventrally flattened.

3. Neck become short and immobile.

4. Bones light and spongy.

5. External ear absent.

6. Limbs become fleshy and fin like expansion or paddle for swimming.

7. Skin becomes smooth and naked.

7.6 STUDY OF WILD ANIMALS

1. Bengal Tiger:

Fig 7.1 Panthera tigris tigris

Classification:

Scientific Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Carnivora

Family :Felidae

Genus: *Panthera*

Species: *tigris*

Scientific Name: *Panthera tigris tigris*

Characteristics: Coat is yellow to light orange, stripes from dark brown to black. Belly and the interior parts of the limbs are white.Body length is 270 cm -310 cm, Weight is from 180 to 258 kg in male, females ranges from 100 to 160 kg . tail is 85 cm -110 cm in length. Body height is 90 cm to 110 cm.Stout teeth and largest canies among felidae measuring from 7.5 cm to 10 cm.

Distribution: Once they use to cover large scale of inhabitat covering a whole of India Sub Continent. Loss of vegetation and large scale hunting has resulted in severe decline in population and its area. Currently they are found in Rajaji National Park, Corbett Park, Bardia-Banke and Tiger conservation unit at Chitwan, Parsa, Valmiki, Dudwa, Kailali, and Sunderbans.

2.Wild Elephants

Fig 7.2 Elephas maximus indica

Classification

Scientific Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Proboscidea

Family :Elephantidae

Genus: *Elephas*

Species: *maximus*

Scientific Name:*Elephas maximus indicus*

Characteristics: Body length is 3.4 mts. Body weight between 2,000 Kg to 5,000 K.g. Back is covex or flat. Indian elephants have smaller ears, but broader skulls and larger trunks than African elephants. Toes are large and broad.

Distribution: Indian elephants are native to mainland Asia: India, Nepal, Bangladesh, Bhutan, Myanmar, Thailand, Malay Peninsular, Laos, China, Cambodia, and Vietnam. They inhabit grasslands, dry deciduous, moist deciduous, evergreen and semi-evergreen forests.

3.Neelgai or Nilgai

Fig 7.3 Boselaphus tragocamelus

Classification

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Family:Bovidae

Genus:*Boselaphus*

Species: *tragocamelus*

Scientific Name: *Boselaphus tragocamelus*

Characteristics: Body height varies from 1–1.5 metres ; males weigh 109–288 kg ,females 100–213 kg . A sturdy thin-legged antelope, A sloping back, a deep neck with a white patch on the throat, a short crest of hair along the neck terminating in a tuft, and white facial spots.

Distribution: The nilgai or blue bull is the largest Asian antelope and is endemic to the Indian subcontinent.They prefer areas with short bushes and scattered trees in scrub forests and grassy plains. They are common in agricultural lands, but hardly occur in dense forest. Major populations occur in the Terai lowlands in the foothills of the Himalayas (northern India), but the antelope is sparsely found in Nepal and Pakistan. .

4.Deers - Hog deer (Ghural)

Fig 7.4 Hyelaphus porcinus

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Family:Cervidae

Genus: Hyelaphus

Species: porcinus

Scientific Name: *Hyelaphus porcinus*

Characteristics: All Deer species have large fissure below each eye, gall bladder is absent, solid horns. Body weight around 50 kg, height around 70 cm. Strong with long body and relatively short legs, and tail.

Distribution: Deer are widely distributed, with indigenous representatives in all continents except Antarctica and Australia. India has a distinction of having the largest number of deer species in the world. Hog Deer historically occurred from Pakistan, throughout northern and northeastern India, including the Himalayan foothill, east across non-Sundaic Southeast Asia and, marginally, southern China (southern Yunnan province), but it is now reduced to isolated subpopulations within this range.

5. Jackal:

Fig 7.5 Canis aureus indicus

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Carnivora

Family:Canidae

Genus :*Canis*

Species*: aureus*

Scientific Name*:Canis aureus indicus*

Characteristics: Body is covered by fur of a mixture of black and white, with buff on the shoulders, ears and legs. Belly, chest and the sides of the legs are creamy white, while the face and lower flanks are grizzled with grey fur.Omnivores, predators of small- to medium-sized animals and proficient scavengers, Long legs, curved canine teeth ,long-distance running. Jackals are crepuscular, most active at dawn and dusk.

Distribution: They are found in India, Pakistan, Bhutan, Myamar and Nepal .

6.Monkeys - Langoor (Black face with grey body)

Fig 7.6 Semnopithecus entellus

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order:Primates

Family:Cercopithecidae

Genus:*Semnopithecus*

Species :*entellus*

Scientific Name: *Semnopithecus entellus*

Characteristics: Largely gray (some more yellowish), with a black face and ears. The head-and-body length is from 51 to 79 cm (20 to 31 in). Their tails, at 69 to 102 cm (27 to 40 in) are always longer than their bodies. Walk quadrupedally, spend half their time on the ground and the other half in the trees. make bipedal hops, climbing and descending supports with the body upright, and leaps.

Distribution: The entire distribution of all gray langur species stretches from the Himalayas in the north to Sri Lanka in the south, and from Bangladesh in the east to Pakistan in the west.

7.Indian Hare :

Fig 7.7 Lepus nigricollis

Classification:

Kingdom: Animalia
Phylum: Chordata
Subphylum: Vertebrata
Class:Mammalia
Order: Lagomorpha
Family:Leporidae
Genus:*Lepus*
Species:*nigricollis*

Scientific Name:*Lepus nigricollis*

Characteristics: Long ears more than 10 cm ,Large powerful hind legs. The two front paws have 5 toes, hind feet have 4 toes. plantigrade animals paws lack pads. Their nails are strong and are used for digging. Body length vary from 40 cm to 70 cm and weight is nearly 7 kg. body is covered patch of black fur.

Distribution: Hare are found in south india. These hares range from far east as Godavari and west till Madhya Pradesh.

8.Newla

Fig 7.8 Herpestes edwardsii

Classification:

Kingdom: Animalia

Phylum: Chordata

Class:Mammalia

Order: Carnivora

Family:Herpestidae

Genus: Herpestes

Species:edwardsii

Scientific Name: Herpestes edwardsii

Characteristics:long faces , small rounded ears, short legs, and long tapering tails.nonretractile claws

Distribution: Mongooses live in southern Asia, Africa, and southern Europe, as well in Fiji, Puerto Rico, and some Caribbean and Hawaiian islands.

9. Wild Pig

Fig 7.9 Sus scrofa

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Family: Suidae

Genus: Sus

Species: scrofa

Scientific Name:*Sus scrofa*

Characteristics:

Body weight range from 90.72 kg to 136.00 kg, body length from 83.82 to 91.5 cm. Skin covered with black coat, head larger and more pointed and its ears smaller and more pointed. The plane of the forehead is straight, while it is concave. Neck is short and thick.

Distribution: This Boar is found in most of wild life sanctuaries in Indian sub continent.

10. Himalayan Tahr

Fig 7.10 Hemitragus jemlahicus

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Family:Bovidae

Subfamily: Caprinae

Genus:*Hemitragus*

Species: *jemlahicus*

Scientific Name: *Hemitragus jemlahicus*

Characteristics: Even toed ungulate mammal, sport thick, reddish wool coats and thick undercoats, a small head, small pointed ears, large eyes, and horns curved backwards. The hooves of the tahr have a rubber-like core which allows for gripping smooth rocks while keratin at the rim of their hooves allow increased hoof durability, which is important for traversing the rocky ground.

Distribution: The Himalayan tahr mainly found on slopes ranging from 2,500 to 5,000 m . They most often inhabit locations where vegetation is exposed for browsing and grazing. During the winter (when snow covers vegetation at higher elevations), they come down on lower-altitude slopes

11.Bharals(Pseudois nayauf) : Blue Sheep

Fig 7.11 Pseudois nayaur(Blue Sheep)

Classification:

Kingdom:Animalia

Phylum:Chordata

Class: Mammalia

Order: Artiodactyla

Family:Bovidae

Subfamily:Caprinae

Genus:*Pseudois*

Species:*nayaur*

Scientific Name:*Pseudois nayaur*

Characteristics: A medium-sized sheep with body length vary from 115 to 165 cm, body weight from 35 to 75 Kg , Body height from 69 to 91 cm, Body is covered by short, dense coat grey in colour, with a bluish sheen. The underparts and backs of the legs are white, while the chest and fronts of the legs are black.

Distribution: The bharal or Himalayan blue sheep or naur (Pseudois nayaur) is found in the high Himalayas of India, Nepal, Bhutan, Tibet, and Pakista

7.7 STUDY OF RARE AND ENDANGERED SPECIES OF UTTRAKHAND STATE

Uttrakhand state located at the foothills of the snow clad Himalayas with lush green vegetation. Uttrakhand Himalaya has a unique setting within the western Himalayan region covering an area of 53,483 sq Km geographical area. It contains fascinating vegetational zone supporting rich variety of flora and fauna including rare and endangered species. There are 6 Nationals Park and 6 wildlife sanctuary in the state.

Some of the threatened faunal species are:-

1.*Gyps bengalensis*

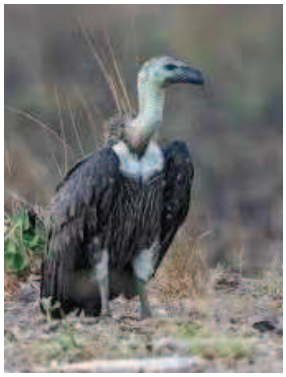

Fig 7.12 Gyps Bengalensis

Scientific Name :*Gyps bengalensis*

Scientific Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Aves

Order: Accipitriforms

Family :Accipitridae

Genus: *Gyps*

Species: b*engalensis*

Common name : White-rumped Vulture.

Habitat: Himalayan vulture is found mainly in higher regions of Himalayas, Pamirs and Kazakistan. This is a huge bird found in the Himalayas. Adults have a ruff that is long and pale brown with white streaks. The ruff feathers are long and spiky. Head is covered in down which is yellowish in adults but whitish in immature vultures.

Feaethers : Length of bird is 40.6- 45.3 inch, wing 755-805 mm in length and tail (355 – 405 mm).

Conservation: The most serious potential threat to the species is thought to be mortality caused by feeding on livestock infested with Diclofenac, a non-steroidal anti-inflammatory drug(NSAID). Govt. of India, ban has been imposed on the use of Diclofenac for veterinary use.

Importance: Vultures have ecological, social and cultural significance. They are nature's scavenger, feeding on carcasses of animal. This way helps in cleaning environment.

Endangered Status: Vultures are listed in "Critical Endangered" Category.

***2.Sarcogypscalvus*:**

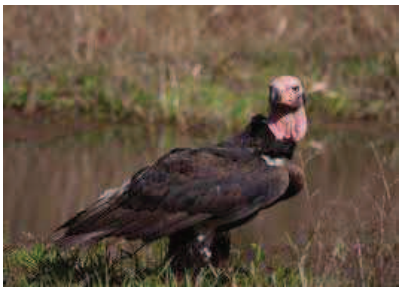

Fig 7.13 Sarcogyps calvus

Scientific Name :*Sarcogyps calvus*

Scientific Classification:

Kingdom: Animalia
Phylum :Chordata
Class :Aves
Order: Accipitriforms
Family :Accipitridae
Genus: *Sarcogyps*
Species: calvus

Common name : The Red-headed Vulture (Sarcogypscalvus), also known as the Asian King Vulture, Indian Black Vulture or Pondicherry Vulture.

Habitat: This Vulture is found mainly in indian continent This is a medium size bird foundin deciduous forests and foothills and river valleys. It is usually found up to an altitude of 3000m from sea level.

Distribution: It is mainly found in the Indian subcontinent, with small disjunct populations in some parts of Southeast Asia. In Uttarakhand this vulture can occasionally be sighted in the lower to middle hills, mostly in pairs.

Feaethers: Length of bird is 30.0- 34.0 inch, wing 200-260 mm in length and tail (199 – 260 mm). It has a prominent naked head: deep-red to orange in the adult, paler red in the juvenile. It has a black body with pale grey band at the base of the flight feathers.

Conservation: The most serious potential threat to the species is thought to be mortality caused by feeding on livestock infested with Diclofenac, a non-steroidal anti-inflammatory drug (NSAID).Govt. of India, ban has been imposed on the use of Diclofenac for veterinary use.

Importance: Vultures have ecological, social and culture significance. They are nature's scavenger feeding on carcasses of animal. This way helps in cleaning environment.

Endangered Status: This species is currently in near threatened list by IUCN.

***3.Hyaenahyaena* (Striped hyena)**

Fig 7.14 Hyaena hyaena

Scientific Name :*Hyaena hyaena*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Carnivora

Family :Hyaenidae

Genus :*Hyaena*

Species: *hyaena*

Common name : Striped Hyena

Distribution: Once widely distributed in Indian Sub-continent, mostly in drier tracts, this animal is now restricted to fewer pockets, especially in and around Protected Areas. A small population exists in Chilla Range of Rajaji National Park.

Habitat: Global distribution includes African countries, Georgia, Iran, Iraq, Israel, Jordan, Mali, Nepal, Saudi Arabia, Turkey, Turkmenistan and Uzbekistan. It is possibly extinct from Kuwait, Qatar and United Arab Emirates.

Feaethers: Striped Hyena is medium sized canie. It sports 5–9 distinct vertical stripes on the flanks, with clearer black transverse and horizontal stripes on the legs. Males weigh between 26–41 kilograms while females weigh 26–34 kg. Excluding the tail, total body length varies between 1.0 and 1.15 m. Shoulder height is between 0.66 and 0.75 m

Conservation: Several awareness programme have been launched to sensitize the villages living near the protected area about its habits.

Importance: striped hyena is actually a scanvanger but it also feed on live carrion animals. They helps in keeping a check on carrion population.

Endangered Status: These are listed as near threated by IUCN.

***4.Tragopan melanocephalus*:**

Fig 7.15 Tragopan melanocephalus

Scientific Name : Tragopan melanocephalus

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Aves

Order: Galliformes

Family :Phasianidae

Genus: *Tragopan*

Species: *melanocephalus*

Common name : Western Tragopan

Vernacular name : Jujurana (Himachali-Kullu, Mandi), Fulgar, Fulgari (Himachali-Chamba), Pyara (Kinnaur), Jyazi (Bushahr) Sonalu, Solalee (Kashmiri), Jewar (Garhwali), Sing monal (Pahari-N.W. Himalaya)

Distribution: Resident and rare. Distributed in the northwestern and western Himalayas (Jammu & Kashmir, Himachal Pradesh and Uttarakhand), mostly between 2,400-3,600 m (down to 2,000 m in winter).

Habitat: It is a medium sized inhabits upper temperate forests between 2,400 and 3,600 m in summer, and in winter, dense coniferous and broad-leaved forests between 2,000 to 2,800 m

elevations. In Uttarakhand birds have been sighted in PanwaliKantha alpine meadow in 2007 by researchers of Wildlife Institute of India, Dehradun.

Feaethers: Very shy, extremely wary and skulking, but sometimes forages in forest glades or on open slopes. Feeds on the ground, mainly in early mornings and late evenings. It roosts in trees, where it is well concealed.

Conservation: It was accorded state bird of Himanchal Pradesh in 2007.A captive breeding program has been launched in Himanchal Pradesh in 2007.

Importance:*Tragopan melanocephalus* have an impact on the plants and prey they eat and are an important food source for their predators

Endangered Status: They are listed as near threated by IUCN.

5.Tragopan satyra

Fig 7.16 Tragopan satyra

Scientific Name :*Tragopan satyra*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Aves

Order: Galliformes

Family :Phasianidae

Genus: *Tragopan*

Species: *satyra*

Commanname : Satyr Tragopan Vernacular Names : Lungi (Hindi, Garhwali, Kumaoni), Bop (Bhotia), Tarrhyak (Sikkim-Lepch)

Distribution : Resident and rare. Distributed in the western, central and eastern Himalayas (eastern Uttarakhand, northern West Bengal, Sikkim and western Arunachal Pradesh), mostly between 2,400-4,500 m (down to 2,000 m in winter).

Habitat: Inhabits dense undergrowth or Bamboo clumps in temperate and subalpine oak-rhododendron, coniferous or broad leaved forests, scrub in steep hillsides, and narrow ravines.

Feaethers: Very shy, extremely wary and skulking, but sometimes forages in forest glades or on open slopes. Feeds on the ground, mainly in early mornings and late evenings

Conservation: Their populations are fragmented and affected by habitat loss as a result of overgrazing and removal of materials used as fuel for fire. They are also threatened by hunting. They are protected in some areas of their range. Captive bredding has been taken up.

Importance: Satyr tragopans have an impact on the plants and prey they eat and are an important food source for their predators.

Endangered Status: These are listed as near threated by IUCN.

***6.Ophrysia superciliosa*:**

Fig 7.17 Ophrysia supercillosa

Scientific Name :*Ophrysia superciliosa*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Aves

Order: Galliformes

Family :Phasianidae

Genus: *Ophrysia*

Species: *supercillosa*

Common Name : Himalayan Quail

Vernacular Names : Chota kala teetar

Distribution & Habitat: Former status unknown, occurred in Western Himalayas in Uttarakhand at 1,650-2,100 m; now presumed extinct, last confirmed sighting in 1890, but may still be surviving. There is a recent set of possible sightings around Naini Tal in 2003.

Habitat: Old records are from Jharipani, Banog and Bhadraj (near Mussoorie) and Sher-ka-danda (near Nainital). Reported to occur in long grass and brushwood on steep hillsides.

Feaethers:A medium-sized quail belonging to the pheasant family. 25 cm. Rather nondescript quail with red bill and legs.

Conservation: No proper survey has been done.

Importance: Not known.

Endangered Status: They are listed as critically endangered by IUCN.

***7.Moschu schrysogaster*:**

Fig 7.18 Moschus chrysogaster

Scientific Name :*Moschus chrysogaster*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Maschidae

Family :Moschidae

Genre: *Moschus*

Species: *chrysogaster*

Common Name : Himalayan Musk Deer, Local name : Kasturimrig

Distribution: The Himalayan musk deer inhabits the forested areas in the Himalayas of Nepal, Bhutan, India, Pakistan & China above 2,500 m above sea level and the treeline.

Habitat: In Uttarakhand, it is found in Nanda Devi NP , Valley of Flowers NP, Gangotri NP, Kedarnath WLS, Govind WLS, Askot WLS and many other Reserve Forest Divisions in the high Himalaya.

Feathers:well-developed dew claws, broad toes, a dense coat of coarse hairs, lack antlers. Deer have a stocky body type; their hind legs are also significantly longer and more muscular than their shorter, thinner forelimbs. Musk Male secrets a waxy substance called musk from a gland in the abdomen. This musk is also used in the manufacture of perfumes and medicines.

Conservation: Himalayan musk deer is the 'State Animal' of Uttarakhand. Strict enforcement of Anti poaching law is a key priority for its protection. Captive populations are present Musk deer Breeding Centre, Kanchulakharakh (near Tungnath in Chamoli District) and at the Research Center of Central Council of Research in Siddha & Ayurveda at Dharamgarh, Bageshwar District

Importance: Musk Deer produces musks. It is in demand for the manufacture of perfumes & medicine.

Endangered status: They are listed as endangered by IUCN.

***8.Uncia uncia* (snow leopard):**

Fig 7.19 Uncia uncia

Scientific Name :*Uncia uncia*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Carnivora

Family :Felidae

Genre :*Uncia*

Species: *uncia*

Common name : Barhal he (Pahari), Barfani cheetah (Urdu), Shan (Ladakhi), Burhelhaye (Bhotia), Sheen-e-suh (Kashmiri)

Distribution: The Snow leopard is found in Siberia, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan to the Hindu Kush in eastern Afghanistan, Karakoram in northern Pakistan, in the Pamir Mountains, and in the high altitudes of the Himalayas in India, Nepal, and Bhutan, and the Tibetan Plateau occupies In Uttarakhand it is found in the alpine areas of Uttarkashi, Tehri, Chamoli and Pithoragarh districts. However, it is best seen at Ladakh (J&K).

Habitat: Snow leopard lives in high mountain area. In summer, snow leopards usually live above the tree line on mountainous meadows and in rocky regions at an altitude from 2,700 to 6,000 m (8,900 to 20,000 ft). In winter, snow leopards come down into the forests to an altitude of around 1,200 to 2,000 m (3,900 to 6,600 ft).

FeaEthers: Body length is around 1-1.1 meter, tail between 0.8 – 1 meter. Body weight between 35-75 kg

Conservation: Numerous agencies are working to conserve snow leopard & its threatened ecosystem. These list include the Snow Leopard Trust, the Snow Leopard Conservancy, the Snow Leopard Network, and the Panthera Corporation.

Importance: Bones, skin & organs of these leopards are used in Traditional Asian medicine.

Endangered status: These are listed as endangered by IUCN.

***9.Ursus arctos isabellinus*:**

Fig 7.20 Ursus arctos isabellinus

Scientific Name :*Ursusarctos isabellinus*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Carnivorae

Family :Ursidae

Species: *arctos*

Subspecies: *isabellinus*

Common Name : Himalayan brown bear (English), Lalbhalu or Burrabhalu (Hindi)

Distribution: The Himalayan brown bear is reported to be found in rolling alpine meadows (>3,000 m).

Habitat: The Himalayan brown bear is the largest bear in India that is found in the high altitudes of the Himalaya.

Feaethers: It can be easily distinguished by its brown coat that varies seasonally from dark to light, and the white tips to the fur may give the coat a silvery tinge. Body weight vary from 300 to 780 kg

Conservation: The Himalayan brown bear is listed in Schedule I of the Indian Wildlife Protection Act, 1972. Several national park and wild life sanctuary like Danchigam wild life sanctuary have been established to protect the animal from human intervention.

Importance: Bear body parts are used for medicinal and ornamental purpose.

Endangered status: They are listed as critically endangered.

***10.Cervus duvaucelii* (Cuvier):**

Fig 7.21 Cervus duvaucelii

Scientific Name :*Cervus duvaucelii*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Artiodactyla

Family: Cervidae

Genus: *Rcervus*

Species: *duvaucelii*

Common Name : Barasingha (Swamp deer)

Distribution: Barasinghas used to inhabit the basins of the Indus, Ganges and Brahmaputra Rivers, as well as central India as far as the Godavari River. Due to large scale loss of vegetation and hunting, currently they are limited to few protected wild life sanctuary.

Habitat: Swamp deer are mainly grazers. They feed on grasses and aquatic plants, foremost on Saccharum, Imperatacylindrica, Narengaporphyrocoma, Phragmiteskarka, Oryzarufipogon, Hygroryza and Hydrilla. They feed throughout the day with peaks during the mornings and late afternoons to evenings. In winter and monsoon, they drink water twice, and thrice or more in summer. In the hot season, they rest in the shade of trees during the day.

Feaethers: The Barasingha is a long-legged, long-bodied, medium sized deer with large, scythe shaped antlers and large, spreadable hooves. The head-body length is about 180 cm, height at the shoulder is 115-125 cm. The antlers grow up to a length of 104 cm.

Conservation: The species is listed on Appendix I of the Convention on International Trade in Endangered Species (CITES), which bans international trade in this species. It is also protected under the Indian Wildlife Protection Act of 1972.

Importance: This deer body part has been used as food and ornamental purpose.

Endangered status: They are listed as Vulnerable

***11.Melursusursinus*:**

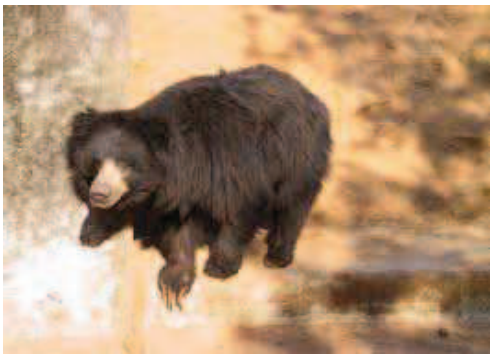

Fig 7.22 Melursus ursinus

Scientific Name :*Melursus ursinus*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order: Carnivora

Family :Ursidae

Genus: *Melursus*

Species: *ursinus*

Common Name : Sloth bear (English), Reechn (Hindi).

Distribution: Sloth bear is found throughout India, Sri Lanka, and further north into Bangladesh, Nepal, and Bhutan. In Uttarakhand, a small population (<30 individuals) may occur between Chilla range of Rajaji and Corbett TR.

Habitat: Sloth bears are omnivorous, although their diet typically includes a large proportion of insect foods. Their diet includes leaves, honey, flowers, and fruits. They are mainly nocturnal.

Feachers: Sloth bears have a shaggy black coat, especially over the shoulders. Long snout, a light "U" or "Y" shaped patch on their chests.

Conservation: The government of India has banned use of sloth bears for entertainment. The sloth bear is listed in Schedule I of the Indian Wildlife Protection Act, 1972, International trade of the sloth bear is prohibited. Many organizations are helping in the conservation and preservation of sloth bears in safe places like wild sancutury like Daroji bear sanctuary, Karnataka

Importance: Bear's body parts are used for food and ornamental purpose.

Endangered status: These are vulnerable by IUCN.

12.Panthera tigris tigris

Fig 7.23 Panthera tigris

Scientific Name :*Panthera tigris*

Classification:

Kingdom: Animalia

Phylum :Chordata

Class :Mammalia

Order:Carnivora

Family :Felidae

Genus: *Panthera*

Species: *tigris*

Subspecies: *tigris*

Common Name : Royal Bengal Tiger

Distribution: In the Indian subcontinent, tigers inhabit tropical moist evergreen forests, tropical dry forests, tropical and subtropical moist deciduous forests, mangroves, subtropical and temperate upland forests, and alluvial grasslands. They are found from Assam, Bengal to Gangetic plain, forest of Western Ghats.

Habitat: Tigers can occupy a wide range of habitat but require sufficient cover, proximity to water and abundance of prey.

Feachers: The body length is 270 cm -310 cm, tail is 85 cm to 110 cm long. The coloration varies between shades of orange and brown with white ventral areas & distinctive vertical black stripes, whose patterns are unique to each individual.

Conservation: In 1972, "Project Tiger" was launched with sole objective of ensuring a viable size of tiger populations and preserving its area. This has resulted in arresting the decline of tiger population.

Importance: Tiger is carnivorous. It sits on top of the food chain helping in regulating the herbivorous animal population. Further its bones are used as medicine in traditional chinese medicine.

Endangered status: Declare endangered by IUCN.

13.Himalayan Serow :

Fig 7.24 Capricornis thar

Scientific Name :*Capricornis thar*

Classification:

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Artiodactyla
Family:Bovidae
Subfamily: Caprinae

Genus:*Capricornis*

Species: *thar*

Common Name:serow (Himalayan Thar)

Distribution: Himalayan serows are known to occur in east and southeast Bangladesh, Bhutan, Nepal, Northern India including Sikkim and provinces east of Bangladesh, Tibet, and probably into Western Myanmar.

Habitat: The Serow inhabits forests and wooded gorges in the mountains, at elevations from 2,000 to 3,330 metres (6,000 to 10,000 feet), as well as grassland and shrub land, at lower altitudes.

Feachers: Goat-antelope , goat-like body, short limbs and long donkey-like ears. Body length vary from 140 to 180 cm, weighs from 85 to 140 kg and height of nearly 1m. conical horns are ridged at the base and slope backwards. Body is covered by fur which is reddish chestnut to black with some white on the chest and lower parts.

Conservation: Capricornisthar is listed in CITES Appendix I and in Schedule I of the Wildlife Protection Act (1972).

Importance: Serow is herbivorous so it use as a food for leopards and bears. It is also hunted by humans for flesh. Its body part are used in traditional chinese medicine.Serow oil has bone and joint healing properties.

Endangered status: Near Threatened on the IUCN Red List

14.Leopard

Fig 7.25 Panthera pardus fusca

Scientific Name: *Panthera pardus fusca*

Classification:

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Carnivora

Family: Felidae

Genus: *Panthera*

Species: *pardus*

Subspecies: f*usca*

Common Name: Tendua

Distribution: Indian leopard is distributed all over India, in Nepal, Bhutan and parts of Pakistan.

Habitat: They inhabits tropical rain forests, dry deciduous forests, temperate forests and northern coniferous forests but does not occur in the mangrove forests of the Sundarbans

Feathers: Body length vary from 127 cm to 142 cm, weight between 29 kg to 34 kg, strong legs, long tail. short ears and small, yellowish grey eyes, light grey ocular bulbs. Body coat is spotted and rosetted on pale yellow to yellowish brown or golden background, spots fade toward the white underbelly and the insides and lower parts of the legs

Conservation: Panthera pardus is listed in CITES Appendix

Importance: Panthera feeds on small mammals and birds herbivorous like deer, pig , hare and pigfowlsetc. It helps in checking their population. Panthera body parts and skin is used as ornaments and in traditional chinese medicine.

Endangered Status: The species Panthera pardus is listed as vulnerable on the IUCN Red List

7.8 *SUMMARY*

Environmental Biology is a complex composition of physical, chemical and biotic factors that affects the living organisms in an ecosystem. Currently, it has become an interdisciplinary academic field that integrates physical, biological and information sciences to the study of the environment, and the solution of environmental problems. Growing human population with increasing lust for resources and material has resulted in large scale destruction of ecosystem. This has resulted in shrinking area for wild life. Large scale destruction of forest (deforestation) has forced wild animal population to reduce st extinction level. A lot of flora and fauna species are under a threat of becoming extinct. Uttrakhand state is also not an exception. A selcted list of Indian wild animals and threatened fauna has been discussed.

7.9 GLOSSARY

Camouflage: Camouflage is the use of any combination of materials, coloration, or illumination for concealment, either by making animals or objects hard to see.

Crepucular: Animals who are active during twilight (i.e., the period immediately after dawn and that immediately before dusk).

Gregarious: Animals who lives in groups

Hibernation: Hibernation refers to a season of heterothermy that is characterized by low body temperature, slow breathing and heart rate, and low metabolic rate.

Hydrocoles: Animals who lives in water

IUCN: The International Union for Conservation of Nature is the global authority on the status of the natural world and the measures needed to safeguard it.

Noctural: Active at night**.**

Plantigrade: Walking with the whole sole of foot bearing on the ground.

Quadrepls: Four Footed animals

Scanvanger: Animal who feeds on dead remains.

7.10 SELF ASSESMENT QUESTION

6. Uttarakhand State Animals is _____ .

   b) *Melursus ursinus*(b) *Panthera tigris tigris*

   c)*Cervusduvaucelii*(d) M*oschus chrysogaster*

7. pH of normal Drinking water is _____.

   b) > 7 b) < 7 c)7 d) between 0 and 7.

8. Which of the following is characteristic of a fast-moving stream ecosystem?

   (a) High levels of dissolved oxygen. (b) High salinity

   (c) Large numbers of anaerobes. (d) Eutrophication

9. Which of the following statements best describes the concentration of dissolved oxygen in aquatic ecosystems?

   (a) Dissolved oxygen concentration increases as temperature decreases

   (b) Dissolved oxygen concentration increases with depth

   (c) Dissolved oxygen concentration increases at the air-water interface

   (d) All of the above .

10. The most important human activity leading to extinction of wild life is ___

    b) Pollution (b) Hunting

    c) Destruction of Habitat (d) Forest Fire

6. According to IUCN Red List, what is the status of Brown Bear

   (a) critically endangered species. (b) vulnerable species

   (c) extinct species (d) endangered species.

7. Corbett National Park is famous for

   (a) Tiger (b) Barasingha c) Bear d) Elephant.

8. Kedarnath Wildlife Sanctury is famous for

   (a) Brown Bear b) Musk Deer c) Snow Leopard d) Monal

9. Red Data Book keeps the record of

   (a) Endangered Plants and animals (b) Extinct animals and plants

   (c) Endemic Plants and animals (d) All of above.

10. IUCN is headquarter at _____ .

    (a) Paris France b) Morges Switzerland c) Vienna Austria d) New York U.S.A

11. IUCN is also called as

(a) Man and Biosphere program (b) World Conservation Union

c) World Conservation Consortium (d) World Wide Conservation Union.

12. Endemic species are

(a) rare species (b) species localized in a specific region.

(c) Cosmopolitan in distribution (d) Critically endangered species

Answer:

1(d) 2(c) 3(a) 4(d) 5(c) 6(b) 7(a) 8(b) 9(d) 10(b) 11(b) 12 (b)

7.11 REFERENCES

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1. Singh, S.P., Gupta, S.R ,and Singh, J.S.. 2006. Ecology, Environment Science and Conservation, S.Chand Publishers, New Delhi.

2. Sharma P. D. 2015 Ecology &Environment ,Rastogi Publication Meerut.

7.12 SUGGESTED READING

- Threatened Species of Uttarakhand published by Uttarakhand Biodiversity Board, Dehra Dun.

7.13 TERMINAL QUESTION/ANSWER

4. What is Red Data Book

   Book containing list of endangered species which are on the verge of extinction.

5. Where Wildlife Institute of India located

   Dehra Dun

6. What is major reason for extinction of Species

   Habitat Destruction.

UNIT 8: DEVELOPMENTAL BIOLOGY

CONTENTS

8.1 OBJECTIVE

By the end of this chapter, you will know

1. Study of Chick Embryo Development.
2. Study of Frog Embryo Development
3. A List of Important Embryo Development (Day and Hour Basics) in Chick.
4. A List of Important Embryo Development (Hour Basics) in Frog

8.2 INTRODUCTION

Developmental biology is the study of the process by which animals and plants grow and develop. It also covers regeneration, asexual reproduction and metamorphosis and in the growth and differentiation of stem cells in the adult organism. The developmental biologists try to figure out how a single cell develops into a multicellular organism.

8.3 STUDY OF PERMANENT SLIDE OF CHICK EMBRYO

Chick Embryo after 4 hours incubation:

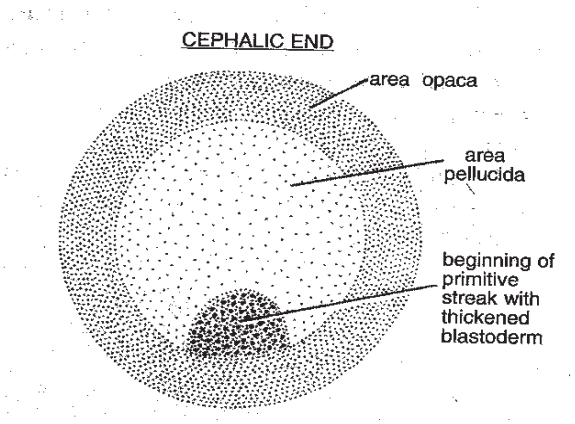


Fig 8.1 Chick Embryo after 4 hours incubation

Comments:

1. It shows differentiation of blastodisk into inner and outer area pellucida and area opace respectively.

2. Egg has cephalic and caudal end.
3. This shows the beginning of primitive streak formation.
4. One quadrant of area pellucida becomes thickened.

Chick Embryo after 16 hours incubation(Whole Mount):

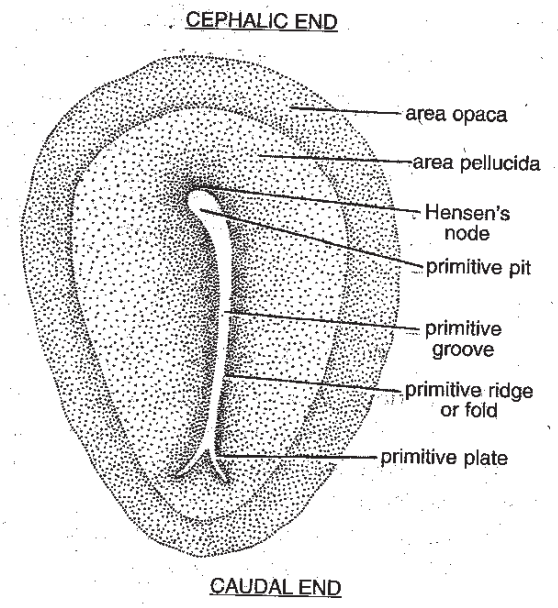


Fig 8.2 Chick Embryo after 16 hours incubation

Comments:

1. It shows a prominent primitive streak.
2. Blastoderm is differentiated into central area pellucida and marginal area opaca.
3. Primitive groove is a central furrow occur in primitive streak and its thickened margin called primitive ridges.
4. Primitive knot or Hensen,s node present at the cephalic end where the cells accumulate.
5. Hensen's node have primitive pit, which is continued with primitive grooves.
6. Primitive streak also is a sight of mesodermal invagination so this is homologus to blastopore of frog.

Chick Embryo after 18 hours incubation(Whole Mount):

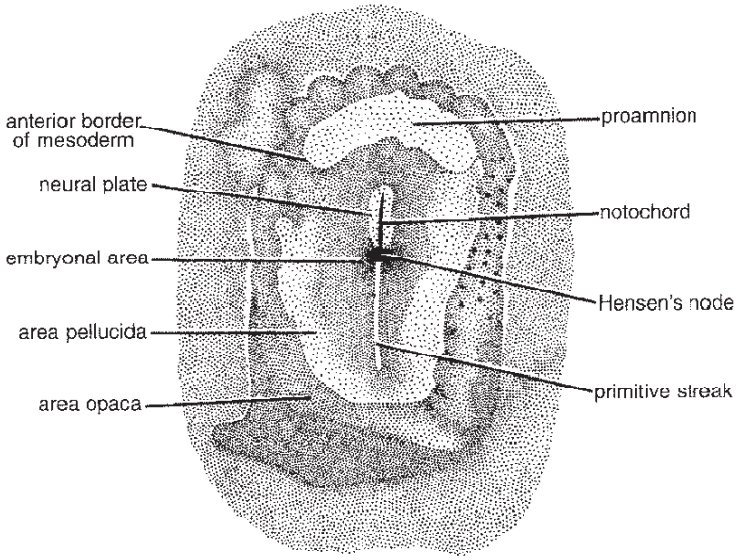


Fig 8.3 Chick Embryo after 18 hours incubation

Comments:

1. Notochord has become elongated to form a conspicuous structure.
2. Notochord extending towards the cephalic region in the midline from Hensen's node.
3. Neural plate develops at the tip of notochord.
4. In anterior region present a small and more translucent portion of area pellucida known as proamnion.
5. Absence of mesoderm.
6. Neural plate and primitive streak are separated by Hensen's node.
7. Primitive streak gradually reduce in size

Chick Embryo after 24 hours incubation(Whole Mount):

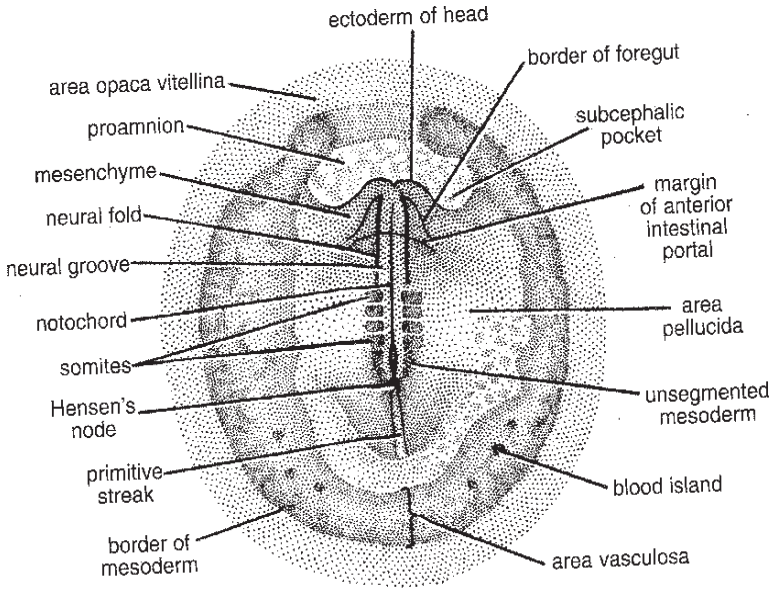


Fig 8.4 Chick Embryo after 24 hours incubation

Comment:

1. Cephalic region undergoes rapid growth.
2. Cephalic region which projects free from blastoderm now turns as head of embryo.
3. Space formed between head and blastoderm is called sub cephalic pocket.
4. Neural folds appears as a pair of dark bands, at cephalic end are more prominent than at caudal end.
5. Four pairs of somites are seen in mid line.
6. Primitive streak gradually decrease in size.

Chick Embryo after 36 hrsincubation(Whole Mount):

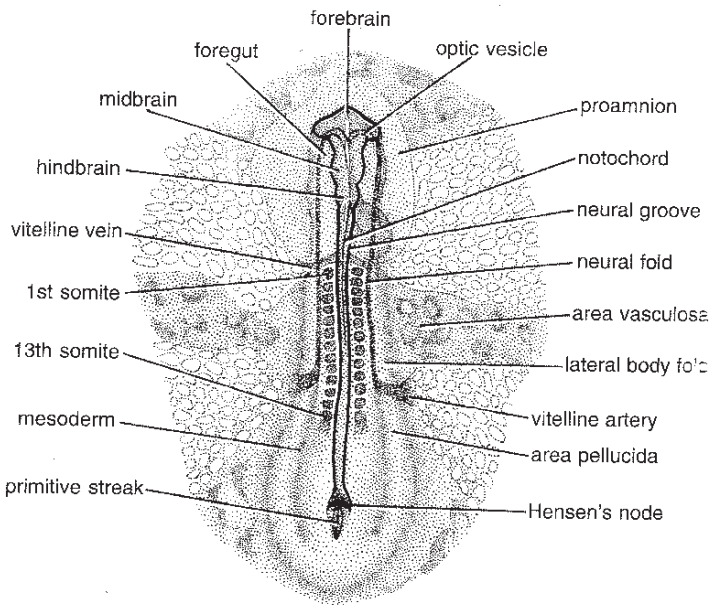


Fig 8.5 Chick Embryo after 36 hours incubation

Comments:

1. Brain is differentiated into fore brain, mid brain & hind brain.
2. Paired lateral outgrowth of fore brain is known as optic vesicles.
3. 13 pairs of somites are formed.
4. Neural tube gets elongated as primitive streak becomes shorter.
5. Vitelline vein &vitelline artery have developed.

Chick Embryo after 72 hrs incubation(Whole Mount):

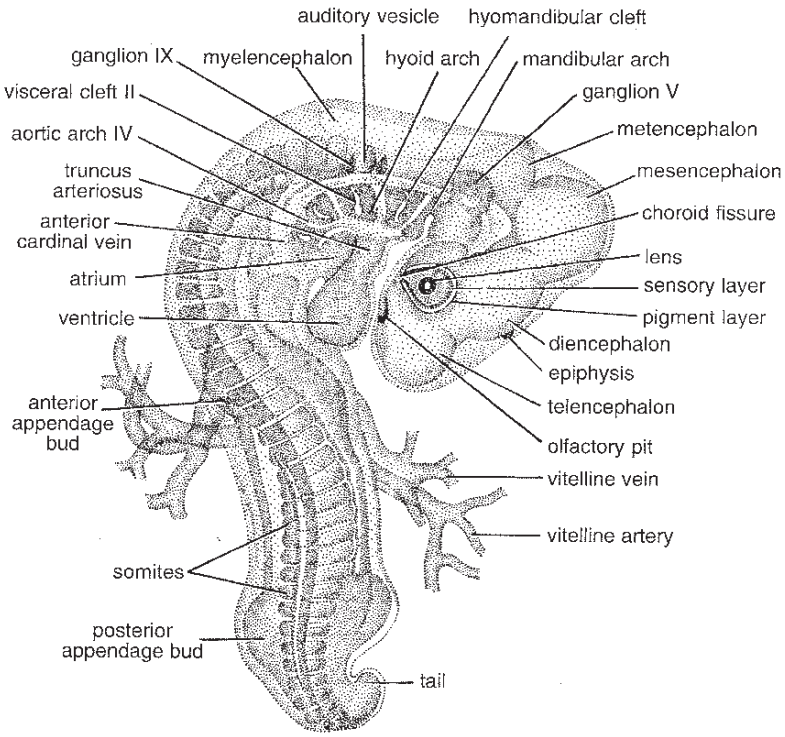


Fig 8.6 Chick Embryo after 72 hours incubation

Comments:

1. It has been affected by torsion throughout its entire length.
2. Mid body region is slightly concave dorsally because embryo is still broadly attached to yolk.
3. Visceral arches developed.
4. Both anterior and posterior appendage buds are seen.
5. Prosencephalon is differentiated into telencephalon and diencephalon.
6. In the eyes, lens, sensory and pigment layers are developed.
7. 36 pairs of somites are present.

Chick Embryo after 96 hrs incubation(Whole Mount):

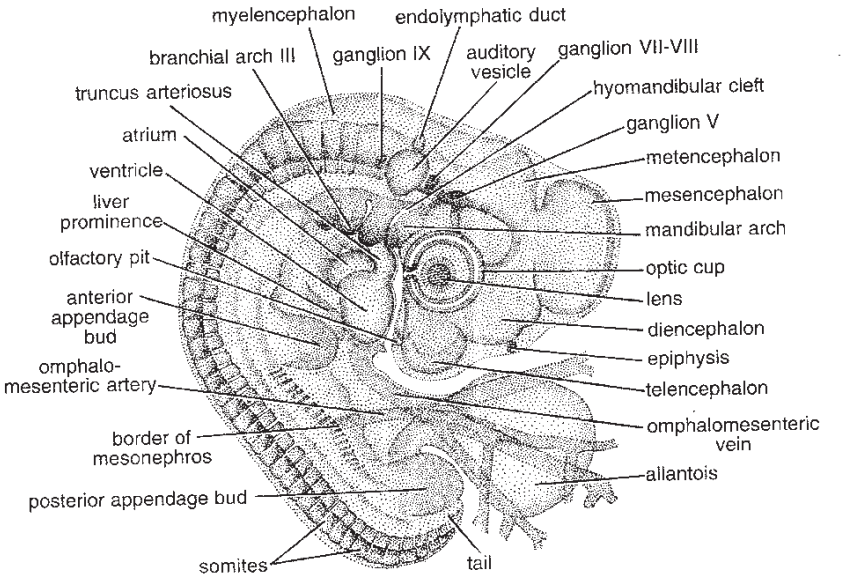


Fig 8.7 Chick Embryo after 96 hours incubation

Comments:

1. Entire body has turned by 90 degree and embryo lies on left side of yolk.
2. Body folds have undercut the embryo and have connected with yolk by a slender stalk.
3. Cranial, cervical , dorsal and caudal flexures have increased resulting in long axis becoming C shaped.
4. Lens have developed.
5. Visceral arches have become thickened.
6. Endolymphatic duct arises from auditory vesicles.
7. 41 pairs of Somites are present.
8. Allantois have appeared and attached with hind limbs.

Chick Embryo after 21 daysincubation(Whole Mount):

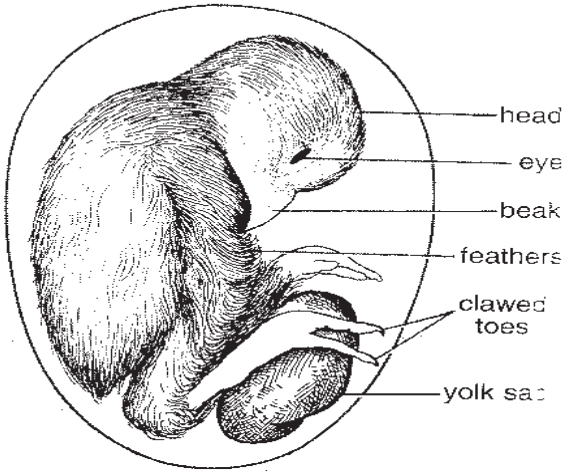


Fig 8.8 Chick Embryo after 21 days incubation (Whole Mount)

1. Body is now completely distinct bearing head, neck and trunk.
2. Beak is seen completely developed.
3. Eyelids are present.
4. Body is covered with tender down feathers except beak and toes.
5. Flying feathers are distinct.

8.4 EMBRYOLOGY OF FROG

Unfertilized egg of frog:

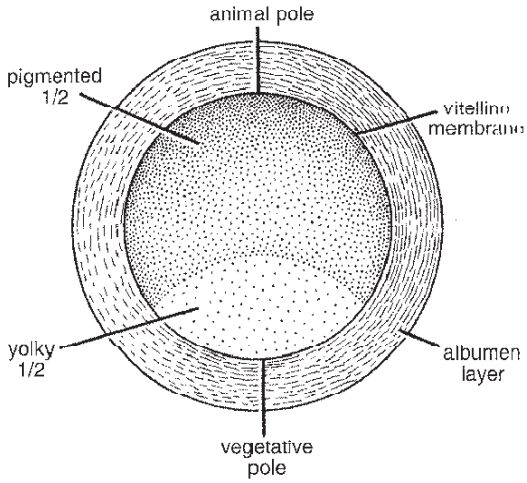


Fig 8.9 Unfertilized egg of Frog

Comments:

1. Egg is spherical shape measuring about 1.6 mm in diameter.
2. It is covered by albumen layer, chorionand vitelline membrane.
3. One half of egg is of blackcolor because of pigmentation and other half is lighter in color.
4. Bulk of yolk is present at the lighter color half.
5. Large egg nucleus lies in pigmented half.
6. There are two pole namely animal pole lying at centre of pigmented area and vegetal pole on opposite end.

L.S of early blastula of Frog:

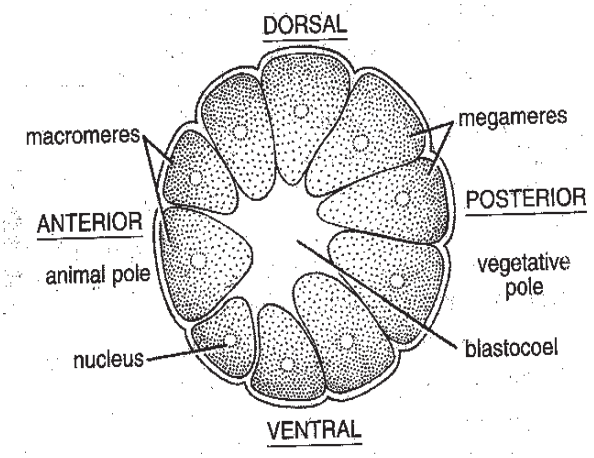


Fig8.10 L.S of early blastula of Frog

Comments:

1. Fertilized egg cleaves and form 8 cell stage called as blastula.
2. Section of blastula shows blastocoel cavity surrounded by the blastomere.
3. Blastomeres are distinguish into two types i.e. micromeres and megameres.
4. Micromeres are smaller and pigmented, located at upper side.
5. Megameres are larger and yolk filled, located at lower side.

V.S of early gastrula of Frog:

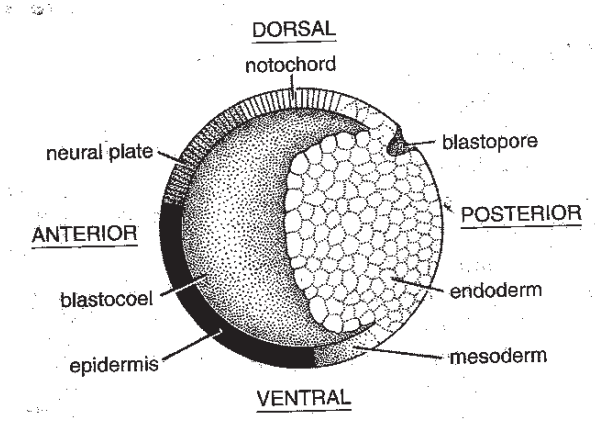


Fig 8.11 V.S of early gastrula of Frog

Comments:

1. Various layers are more or less well differentiated.
2. Notochord and neural plate are well marked.
3. Epidermis is also well differentiated.
4. Blastocoel is large and surrounded by layers of cell.
5. Endoderm is very well developed.
6. Small mesoderm is also seen.

V.S of late gastrula of Frog:

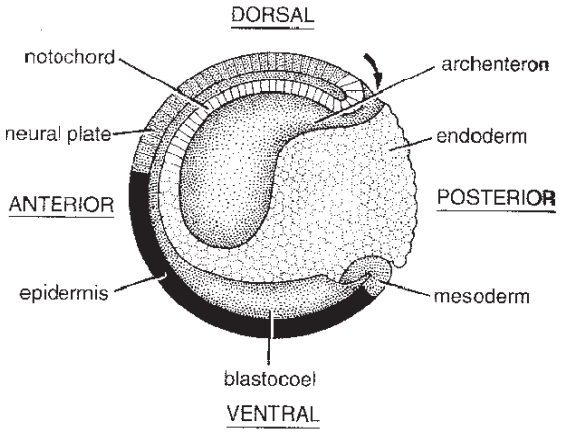


Fig 8.12V.S of late gastrula of Frog

Comments:

1. Various layers are well differentiated.
2. Notochord and neural plate are well marked.
3. Epidermis is well differentiated.
4. Archenteron has also developed.
5. Roof of archenteron is formed by notochordal cell and covered by mesoderm cells.
6. Blastocoel is reduced.
7. Endoderm is well developed.
8. Gastrula has three germinal layer i.e epidermis, mesoderm and endoderm.

Tadpole larva of Frog:

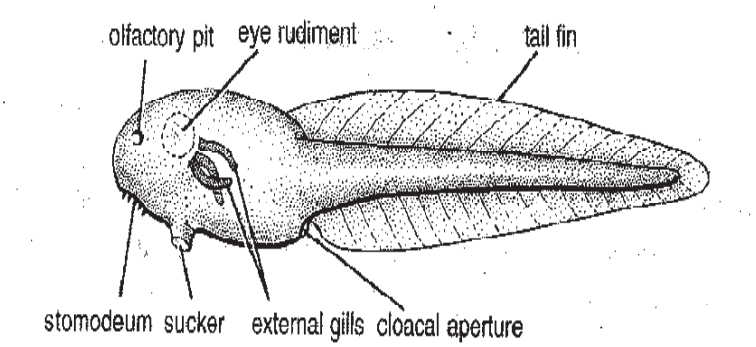


Fig 8.13Tadpole larva of Frog

Comments:

1. Egg develops into tadpole larva.
2. Larva is small blackish fish like with body length vary from 5-7 mm.
3. Body can be divided as body (head, trunk) and tail.
4. Body contains olfactory pits, eye rudiments, mouth sucker, external gills, gut and anus.
5. Tail is long and bears a tail fin on it dorsal and ventral surface.
6. Mouth has horny jaws or horny teeth with coiled intestine.
7. 3 pairs of external feathery gills are present and acts as respiratory organ

T.S of Tadpole through eye region:

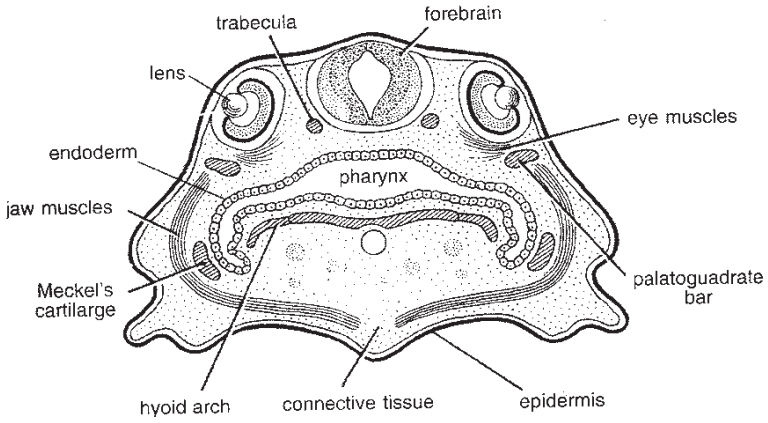
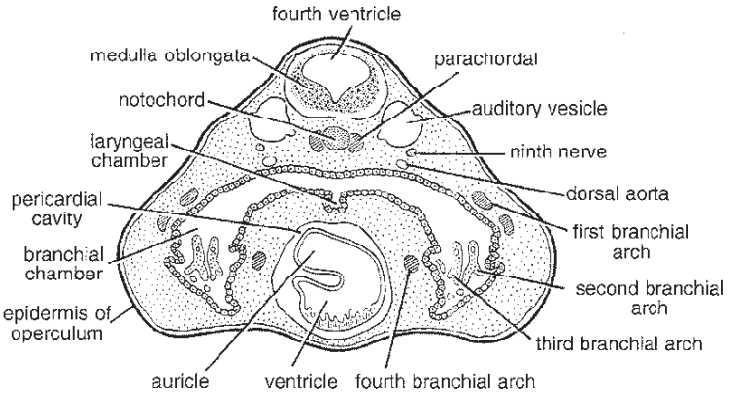


Fig 8.14 T.S of Tadpole through eye region

Comments:

1. Fore brain is visible on dorsal surface.
2. Eyes are present on the lateral side of fore brain.
3. Eyes are conspicuous and large.
4. Eyes are derived from ectoderm and mesoderm.
5. Pharynx is also seen clearly.
6. Hyoid arch is just below the pharynx.
7. Palatoquadrate bars are placed dorsal to the pharynx on lateral side.
8. Meckel's cartilages are present on lateral side of pharynx.
9. Trabeculae are parts of skull derived from neural crests formed by ectodermal cells.
10. Jaw muscles, epidermis and connective tissue are also seen.

T.S of Tadpole through auditory vesicles(ears)



8.15 T.S of Tadpole through auditory vesicles(ears)

Comments:

1. Hind brain has medulla oblongata on dorsal side.
2. Notochord is found below the hind brain enclosed by parchordals on its lateral side.
3. Auditory Vesicles lie on the lateral side below the hind brain.
4. Branchial chamber lies below auditory vesicles and notochord.
5. Dorsal aorta, first, second, third and fourth branchial arches are present on the lateral side.

6. All structures are bounded by muscles and body wall.

T.S of Tadpole through head and gills

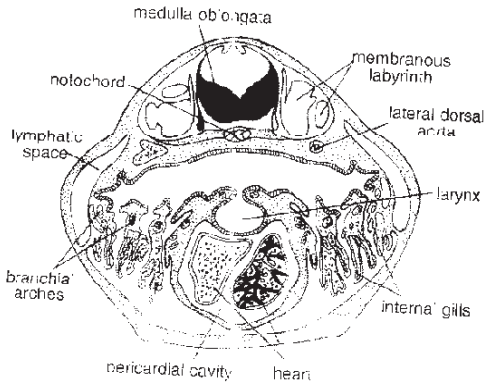


Fig 8.16 T.S of Tadpole through head and gills

Comments:

1. On the dorsal surface lies the medulla oblongata.
2. Membranous labyrinth can be seen.
3. Notochord is seen just below the medulla oblongata.
4. Larynx and Pharynx can also be seen.
5. Heart is just below the pharynx.
6. Branchial arches and internal gills are also seen.
7. Lymphatic spaces are lying on the lateral sides.
8. All above parts are surrounded by muscle, connective tissue and body wall.

8.5 GLOSSARY

Allantoises: Extraembryonic sac like extension of hindgut of amniotes.

Amnion: Extraembryonic, inner, fluid-filled sac composed of a thin double membrane that surrounds The embryo.

Blastula: An animal embryo after cleavage and before gastrulation.

Ectoderm: Outermost layer of body tissue.

Embryo: Early developmental stage of an organism produced from a fertilized egg.

Embryology: Study of origin and development of the embryo.

Endoderm: Innermost layer of body tissue.

Fertilization: Fusion of two gametes(spermatozoa and ova) to form a diploid or polypoid zygote.

Foetus: An unborn or unhatched vertebrate that has passed through the earliest developmental stages**.**

Gastrula: An embryo in the process of gastrulation.

Mesoderm: Middle layer of connective tissue.

Oocytes:A cell that eventually give rise by meiosis to an ovum.

Oogenesis:A process of formation and development of the ovum inside ovary.

Ovum: Female sex cell or gamete which carries female genotype to the offspring and contains stored, food for the development of embryo.

Somites: Somites are block of mesoderm that are located on either side of neural tube in the developing vertebrate embryo.

8.6 SELF ASSESSMENT QUESTION

1. In which stage of development does a zygote go through the structural and functional specialization of groups of cells?

A) growth

B) differentiation

C) morphogenesis

D) fertilization

2. What is fertilization?

A) The fusion of male and female gametes.

B) The division of the zygote into a larger and larger number of smaller cells.

C) The continued division of cells that move inward to form three cellular layers.

D) The development of pattern, shape, and form.

3. What is the term used for eggs that have only a small amount of yolk that are evenly distributed?

A) holoblastic
B) telolecithal
C) isolecithal
D) morula

4. The hollow sphere of cells is called a _____.

A) morula
B) blastula
C) blastocoel
D) blastomeres

5. Which of the following is a germ layer formed during gastrulation?

A) ectoderm
B) mesoderm
C) endoderm
D) all of the above

6. Because the fertilized egg of frogs has most of the yolk at the _____ pole, it is said to be ____.

A) animal, telolecithal
B) animal, isolecithal
C) vegetal, telolecithal
D) vegetal, isolecithal

7. Frog does not invaginate, but produces a ____.

A) blastopore
B) gray crescent
C) blastocoel
D) primitive streak

8. Which of the following are characteristics of reptile eggs?

A) protective shells
B) large amount of yolk
C) intricate membrane system
D) all of the above

9. Which structure in the bird egg functions to remove waste?

A) amnion
B) yolk sac
C) allantois
D) chorion

10. Which structure in the bird egg corresponds to the 'egg white' used in cooking?

A) shell
B) albumen
C) yolk
D) nucleus

11. In birds and reptiles with embryos that develop in shelled eggs, a specialized extra embryonic membrane allows the embryo to exchange gases with the air in the external environment.

a) Yes b) No c) Can't say d) vary from animals to animals

12. In animals, through the process of morulation, the embryo differentiates into three tissue layers: the ectoderm, the endoderm, and the mesoderm.

a) Yes b) No c) Can't say d) vary from animals to animals.

Answer :

1(b) 2(a) 3(c) 4(b) 5(a) 6(b) 7(a) 8(d) 9(c) 10(b) 11(a) 12(b)

Terminal question / answer

7. What are the advantage and disadvantage of taking chicken embryo for embryological research.

   Advantage:

   1) Cheap & Easily Available.

   2) Fairly large embryos

   3) Development can be synchronized by cooling and warming.

   Disadvantages

   1) Embryos reaches to a stage of nearly 20,000 cell inside hen's body

8. Why Amphibians embryo are preferred for embryological experiment.

   1.Embryos are large, can be obtained in large numbers.

   2. Can be maintained easily.

   3. Easy to manipulate with microsurgical instruments.

9. What is the major difference between embryological development of amphibians and birds.

   Amphibian embryos progress through gastrulation by a process known as epiboly while Birds progress through a blastoderm.

10. What characteristics differentiate between birds egg and amphibian egg in physical form.

    Amphibians egg is composed of a series of jellylike layers that protect the developing embryo from desiccation, pathogens and, to a limited extent, predatorswhereas Birds eggs are typical amniote eggs with calcified shells.

8.7 REFERENCES

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UNIT 9 APPLIED ZOOLOGY

CONTENTS

9.1 OBJECTIVES

The study of Specimens, pictures and slides of the economically important animals. Study also includes permanent slides of Protozoans with particular reference to Entamoeba histolytica, Trypanosoma, Leishmania, Giardia, etc.

9.2 INTRODUCTION

Ever since, the beginning of civilization, man has been trying to make use of animals around him for the various purposes and to rear them for increasing their number. If we talk about bees, the first thing that comes to mind might be the picture of a well-structured colony of insects flying around a honeycomb made of perfectly constructed wax cells full of honey. But the truth is that not all bees known nowadays live in hierarchical communities and make honey. Actually, most species of bees develop into a solitary life-form unlike the classical and well-known honey bees (which are so appreciated in Bee-keeping). Through this topic, we'll try to sum up the different life-forms of bees in order to shed light on this chapter. In this topic, we will get introduced with the major aspects of apiculture (Bee- keeping), lac-culture (rearing lac insects) and sericulture (rearing silk moths) and also we will study the specimens, pictures and slide of the parasitic animal.

9.3 STUDY OF SPECIMENS/SLIDES

A **zoological specimen** is an animal or part of an animal which are preserved for scientific use and various uses are i.e. to verify the identification of a species and allow for the study of the concern animal and increase public knowledge of zoology. Zoological specimens are extremely diverse. Examples, the study of the skin of bird and mammal, mounted specimens, skeletal material, casts, pinned insects, dried material, whole animals preserved in spirit and nucroscopic slides. Natural history museums are repositories of zoological specimens.

9.3.1 SPECIMENS STUDY OF APIS

Scientific Classification of Apis	
Kingdom:	Animalia
Phylum	Arthropoda
Class	Insecta
Sub-Class	Prerygota
Order	Hymenoptera
Genus	*Apis*
Species	*A. cerana*
Sub-species	*A.c.indica*
Trinomial Name:	*Apis cerana indica*

Apis cerana indica, the Indian honey bee, is a subspecies of Asiatic honey bee. It is one of the predominant bees found and domesticated in India, Pakistan, Nepal, Burma, Bangladesh, Sri Lanka, Thailand and mainland Asia. Relatively non-aggressive and rarely exhibiting swarming behavior, it is ideal for beekeeping. It is similar to the European honey bee (*Apis mellifera*), which tends to be slightly larger and can be readily distinguished. They usually build multiple combed nests in tree hollows and man-made structures. These bees can adapt to living in purpose-made hives and cavities. Their nesting habit means that they can potentially colonize temperate or mountain areas with prolonged winters or cold temperatures.

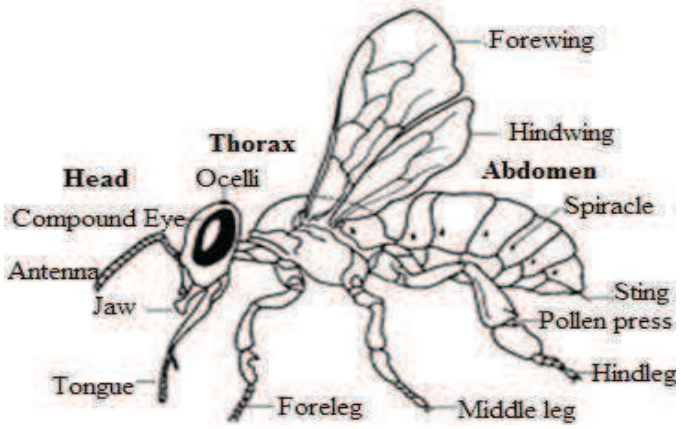


Fig.9.1 Anatomy of Honey bee

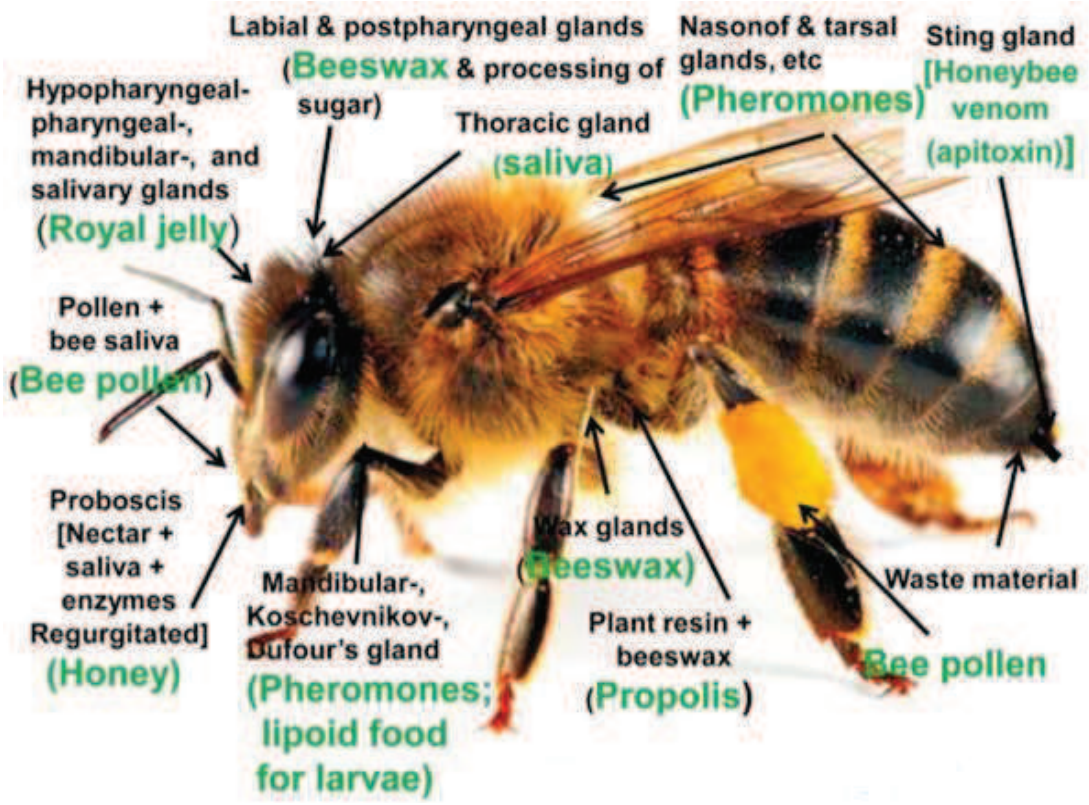


Fig.9.2 Honeybee (Apis mellifera)

Fig.9.3 (A) Life history of Honeybee (Isolated Stages)

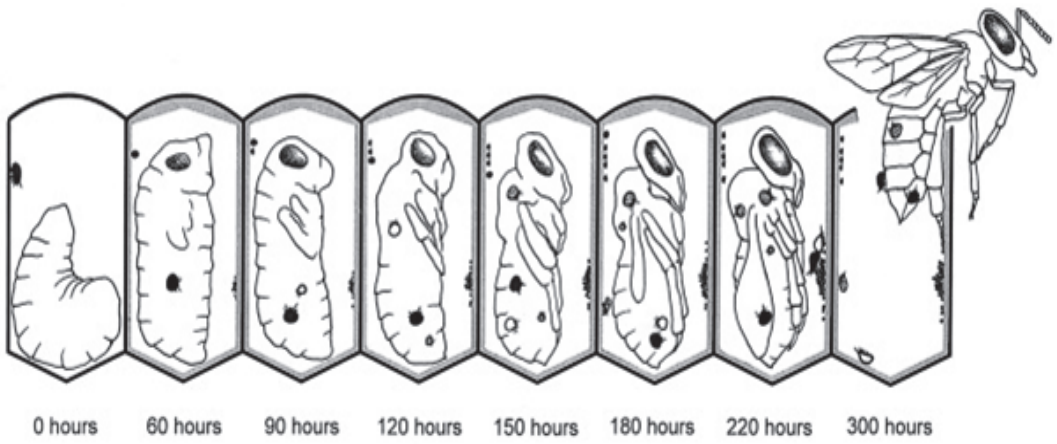


Fig.9.3 (B) Life history of Honeybee (Inside the comb cells)

Common varieties of bees:-

Common species of honey bees that commonly reared are Apis dorsata (rock bee), Apis indica (Indian bee), Apis florea (little bee) and Apis mellifera (Italian bee). Note that beekeepers mostly take care of only species whose names start with "Apis"- that is because only these species produce honey.

- ***Apis dorsata:*** It is a giant bee and yields about 37 kg of honey per colony.
- ***Apis indica:*** It can be easily domesticated and is most commonly used for honey production. The annual yield of honey is 2 to 5 kg per colony.
- ***Apis florea:*** It rarely stings and thus honey extraction from its hive is easy. It produces about 1 kg of honey per colony per year.
- ***Apis mellifera:*** This species has a very typical dance routine to indicate food availability, and like the little bee, stings less. As the common name suggests, this species is not local. However, because of the high amount of honey produced, it is often reared by beekeepers.
-

9.3.2 SPECIMENS STUDY OF SILK MOTH

Bombyx mori is commonly called as the Mulberry silkmoth or Chinese silk worm. The silkworm is the larva or caterpillar or imago of the domestic silkmoth, Bombyx mori. is an economically important insect, being a primary producer of silk.

Systematic Position of *Bombyx mori:-*

Kingdom Animalia

Phylum Arthropoda

Class Insecta

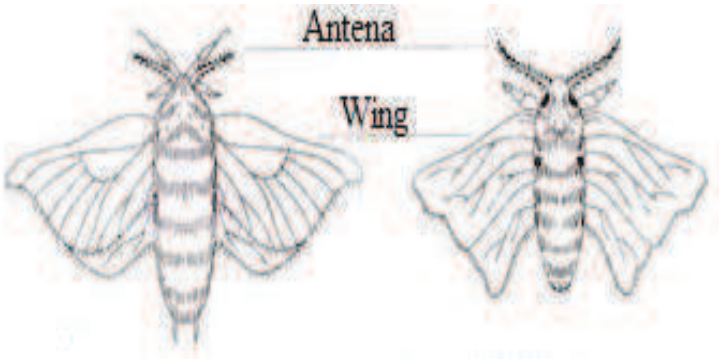
Sub – Class Pterygota

Order Lepidoptera

Family Bombycidae

Genus *Bombyx*

Species *mori*



(A) (B)

Fgi.9.4 Bombyx mori ***or*** *mulberry feeding silkworm (A) Female (B) Male*

Habit Habitat and External feature of the Silk moth:-

Bombyx mori or mulberry worm is fully domesticated animal. The adult moth is primarily concerned with the reproduction. The larva (silk worm) of the silk moth is gluttonous voracious eater, and they feed on the leave of the mulberry tree.Some silkmoth are are unibrooded (Unibrooded are also known as **Univoltine**) and some are multibroded (Multibrooded are also known as **Multivoltine**).The adult moth is about 25 mm long. The female silk moth is larger than the male. The moth is quite robust and creamy-white in colour and the body is distinctly divisible in to three regions, namely as Head thorax and abdomen, the head bears a pair of eyes, a pair of feathery antennae and the mouth parts. The thorax region bears three pair of legs and two pairs of wings and entire body is covered by minute scales.

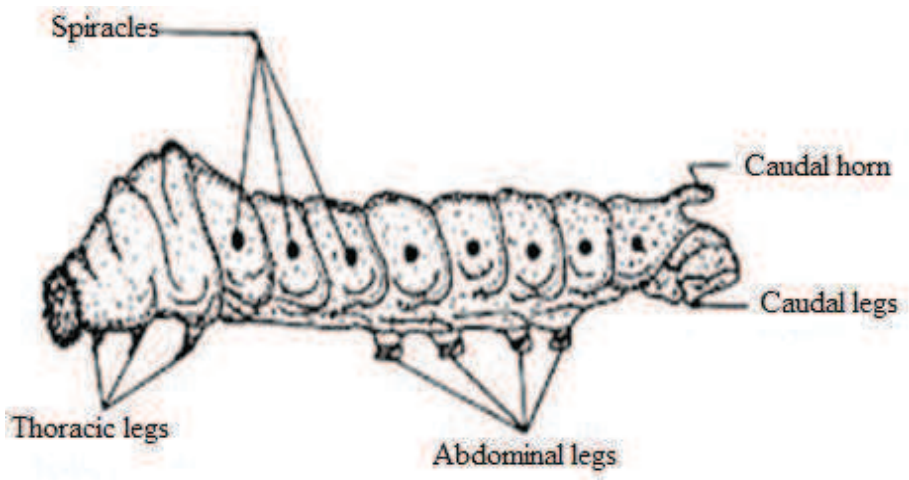


Fig.9.5 Bombyx mori.5th instar larva, Lateral view

Silk:-

The pupa secret a covering around its body and enclosed in it. This is know as cocoon. Thus pupa lives inside cocoon. The formulation of cocoon is called as spinning.

The cocoon is made of one thread of raw silk from 300 to 900 meters (1000 to 3000 feet) long. The silken fibers are very thin. About 2,000 to 5,000 cocoons are needed to make a pound of silk. If the animal is allowed to survive after spinning its cocoon; it makes a hole in the cocoon and exits as a moth. This stage cut the threads and ruin the silk. Instead, silkworm cocoons are thrown into boiling water, which kills the silkworms and also makes the cocoons easier to unravel. Often, the silkworm itself is eaten. The adult silkworms (moths) cannot fly. The silkworm-moths have wings about 2 inches wide and a white hairy body. Females and males are similarly in color. Adult silkworms have small mouths and do not eat.

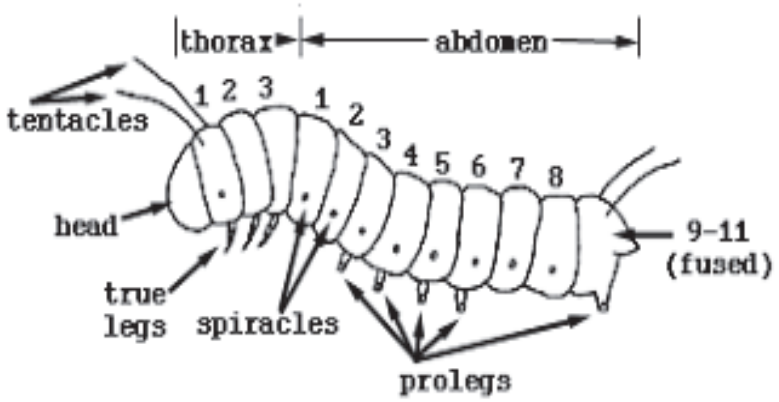


Fig.9.6 Caterpillar anatomy

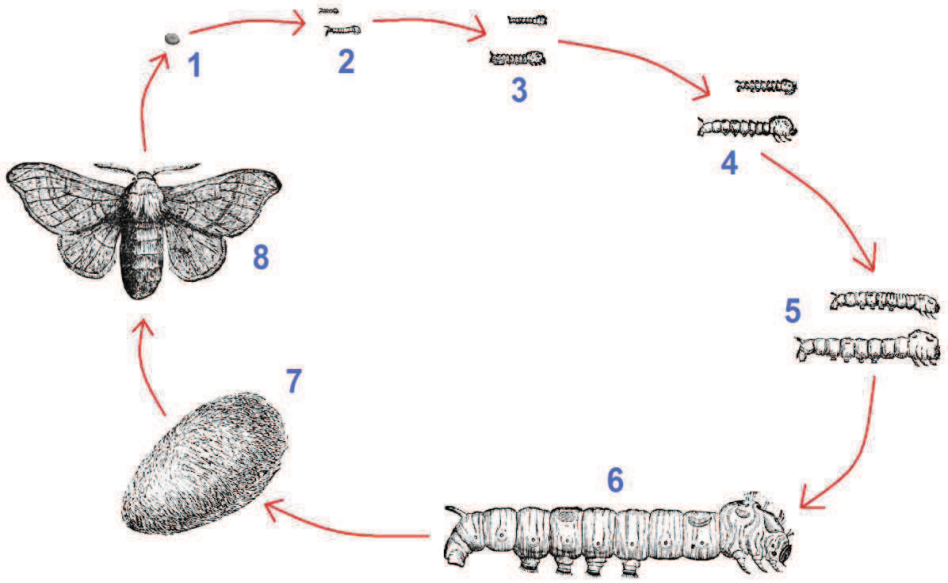
Life history of the *Bombyx mori*:-

The silk moth is dioceous i.e. the sexes are separate. Fertilization is internal and preceded by copulation. The development includes a complicated metamorphosis.

Fig.9.7 Representation of the life cycle of Silk moth in Museum specimen

Eggs:-

Female silkworm lays about 500 eggs at a time. She lays eggs on the leaves of mulberry trees. The eggs are covered with gelatinous secretion by which they stick to the leaves. Female moth (silkworm) lays eggs and dies after laying eggs as she does not eat anything. The eggs are kept in a cool place so that they can be stored for a long time. In a favourable condition, they hatch into larva. Larva is formed in about 2 weeks from eggs at a temperature of 18 to 25 degree celsius.



Life cucle of Bombyx mori (Showing ,etamurphosis)

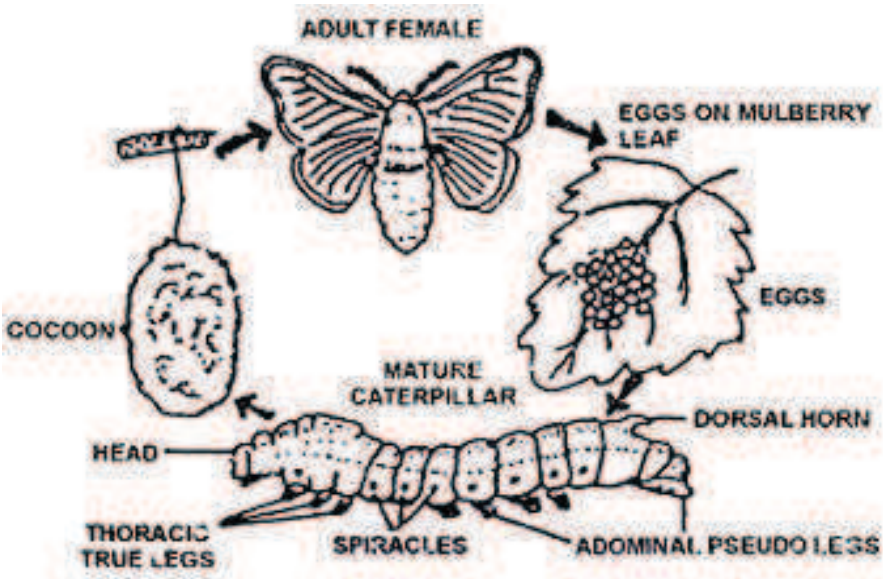


Fig.9.8 Life cycle of Silkmoth

Silk Production:-

Silk is the natural protein fiber, some form of which can woven into textile. The Silk cocoons is composed of primarily of three type of protein, which consist of the glue like glycoprotein sericin and heavy and light chains of the structural fibrous protein fibroin, It has been shown that fibroin resolubilized into an aqueous solution and then form into number of different of different geometrical form to produce regenerated silk. Derived silk is highly biocompatible within the and also demonstrated an impressive range of material properties based on variety of processing protocol. The best known type of silk is obtained from the cocoons of the larvae of the mulberry silkworm (*Bombyx mori)* reared in captivity of sericulture.

Economic Importance of Silkworm:-

A. In business:

1. Sericulture is a small scale, agro based cottage industry.
2. In India, the sericulture is carried out in about 27500 villages.
3. It provides self employment.

B. As source of Employment:

1. In different states of India more than 4 million people are employed in sericulture.
2. Thus, sericulture provides jobs and is a source of income.

C. Clothing:

1. Sericulture substitutes the cotton textile industry.
2. Fine delicate clothes are prepared form silk threads.
3. Silk threads are also exported. India gets large foreign exchange by silk exports.

D. Importance of silk:

There are many other uses of silk:

1. Silk is used in the preparation of garments.
2. Silk is used in the preparation of parachute cords.
3. It is used in Preparation of fishing line and elastic webs.
4. It is used in preparation of race tyres of cars and two wheelers.
5. It is used in insulation coils for telephone and wireless receivers.

9.3.3 SPECIMENS STUDY OF LAC INSECT

Lac is a natural resin. Other forms of all the resin are artificial. That is why it is called 'boon of nature, the insects of lakhs are very subtle and provide financial support by generating lakhs of their body. In scientific language lakhs are called **lasifera lakhha**. The word 'lakha' is derived from the Sanskrit word 'Laksh', possibly due to the number of infants (i.e. attention) infant insects from females. Worms of approximately 34 thousand million are equal to one kg Colorful lacquers and 14 thousand 4 hundred million insects', one kg Kusumi lakhs produce.

Systematic Position:-

Phylum Athropoda

Class Insecta

Sub – Class Pterygota

Order Hemptera

Sub – Order Homoptera

Family Leciferidae

Genus *Tachardia*

Species *lacca*

Lac insect (*Tachardia lacca*) previously known as laccifer lacca is a minute, resinous crawling scale insect which inserts its beak into plant tissue. Suck juices and grows and secretes lac from the hind end the body. Its own body ultimately gets covered with lac in the cell. The male insect (winged) is red in colour in appearance and around 1 to 1.5 mm in length it secretes bright creamy lac where the female (wingless) are larger than the male and measure about 3 to 5 mm in length, the pyriform body of the female is enclosed in a resinous cell where the head, thorax and abdomen are not clearly distinct.

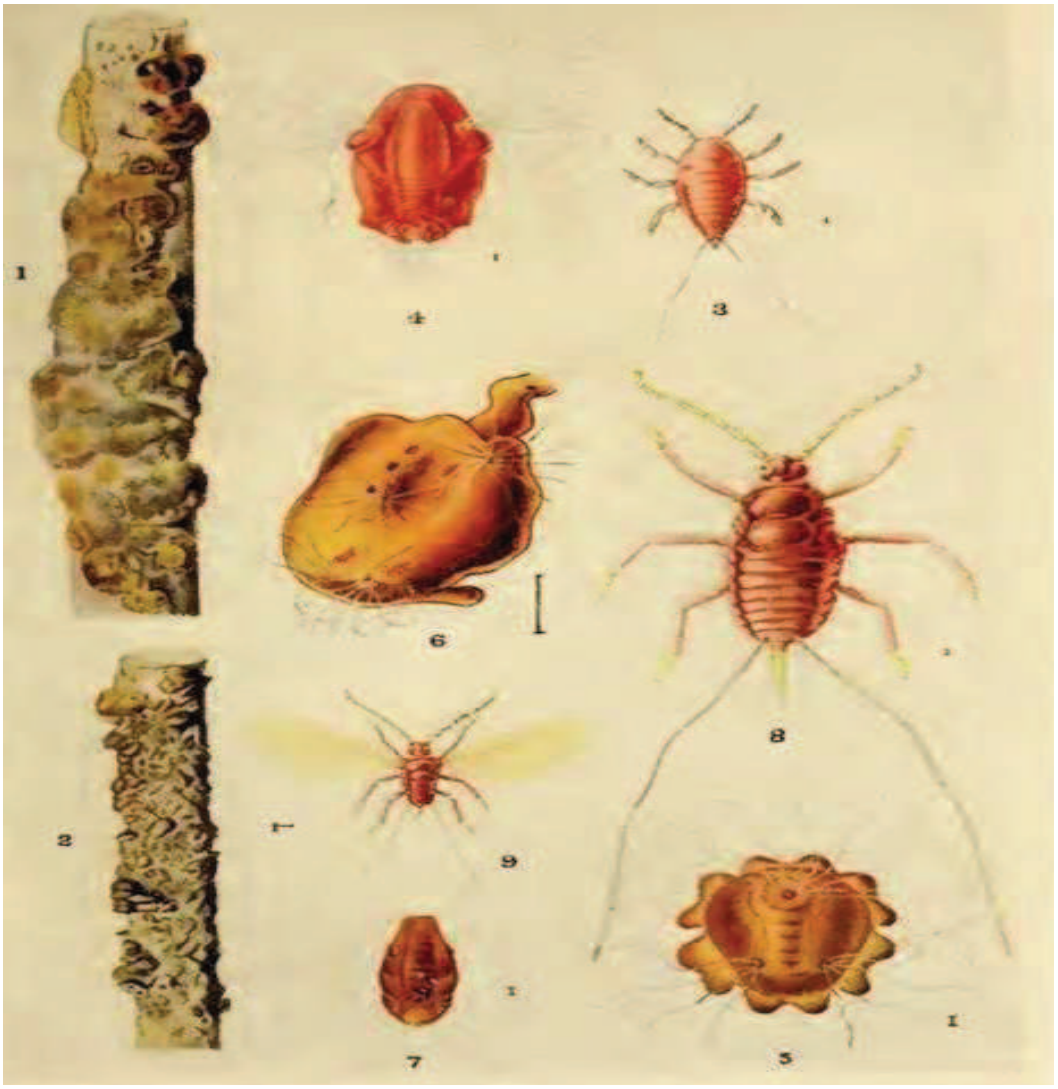


Fig.9.10 museum specimen of lac insect

Life Cycle of the Tachardia lacca:-

It is a minute, crawling scale insect which sucks juices from plant twigs and secretes lac from its hind end of the body. Life cycle comprises of eggs, nymphs and adult male & female insects.

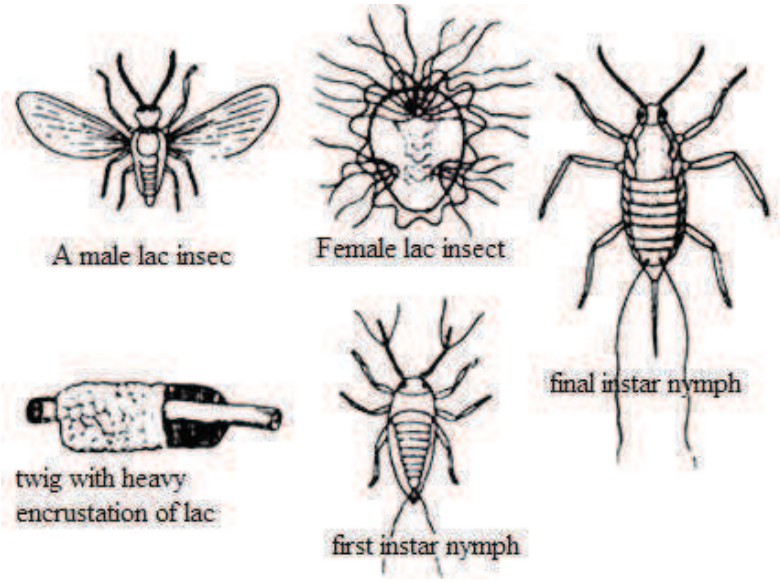


Fig.9.10 Life history of the Tachardia lacca

After fertilization each mature female lays about 200-500 eggs in a cell of lac in which she is enclosed in the month of October & November. After six weeks of incubation, the eggs are hatched into first instar nymphs in the month of November and December. These nymphs emerges out as second instar nymphs in mass called 'swarms'. After sue to eight weeks nymphs metamorphosed into adults. The females get fixed on the host plant & secrets lac till it dies.

Economic Importance:

Lac is a very important material used in making jewelry, paints, varnishes toys, buttons, and photographic material, insulating material for electric goods, ship industry, and office furniture sealing wax and in other things. India produces about 50-60 percent of the total lac output in the world.

9.5 MAJOR CARPS

Indian Major Carps (IMC)

Indian carp or **Indian major carp** is a common name for several species of fish and commonly may refer to the following species now raised in aquaculture in South Asia and other Asian countries where they have been introduced.

- Labeo rohita, the rohu, is an Indian major carp, a fish of the carp family found in rivers in South Asia.
- Catla catla, or **catla,** is an Indian major carp. It is an economically important South Asian freshwater fish of the carp family.
- Cirrhinus cirrhosus, or **mrigal,** is an Indian major carp, a ray-finned fish of the carp family native to rivers in India
- There are some exotic carps such as grass carp, common carp and silver carp.

Rohu (Labeo rohita)

Systematic Position:-

Phylum:	Chordata
Super Class	Pisces
Class:	Actinopterygii
Sub-Class	Actinopteryos
Order	Cypriniformes
Family:	Cyprinidae
Genus:	Labeo
Species:	***rohita***

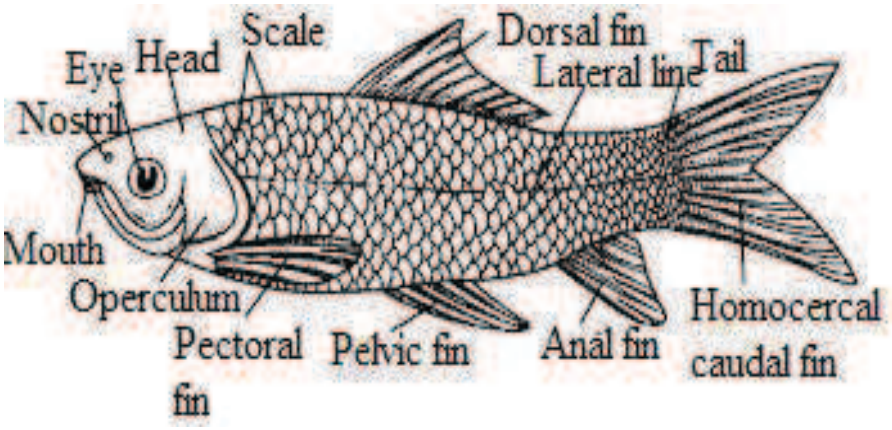


Fig.9.11 Labeo rohita

1. It is a medium sized carp and attains a length of 60 cm.

2. It is widely distributed in India and is often cultured with other major carps.

3. The species is an omnivore with specific food preferences at different life stages

4. It eats mainly zooplankton, but as it grows, it eats more and more phytoplankton, and as a juvenile or adult is a herbivorous column feeder.

5. Rohu reaches sexual maturity between two and five years of age. They generally spawn during the monsoon season

6. The rohu is an important aquacultured freshwater species in South Asia. When cultured, it does not breed in lake ecosystems, so induced spawning is necessary

Catla (Catla catla)

Systematic Position:-

Asin Labeor

Phylum:	Chordate
Class:	Actinopterygii
Super class	Pisces
Genus	Catla
Family:	Cyprinidae
Species:	***G. catla***

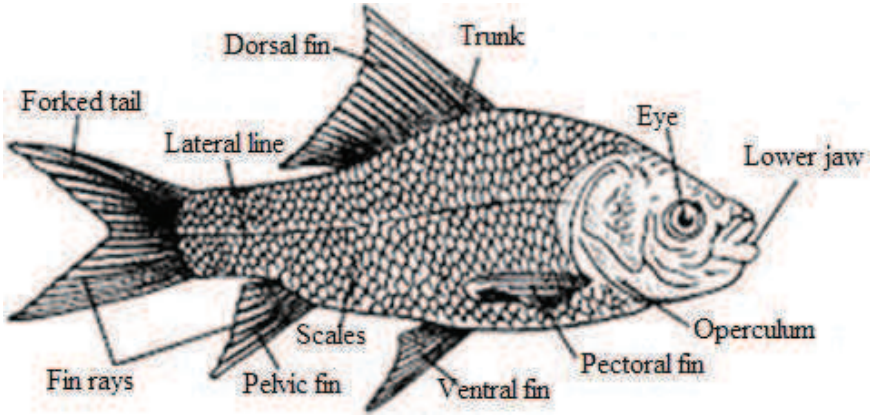


Fig.9.12 *Catla catla*

1. It is largest Indian Carp and commonly known as Catla.

2. Body is elongated broad and stout measuring more than meter length.

3. Colour brakish grey or above and salivary on the sides.

4. Scales are pink or coppery in the center on the dorsal side and whitish below.

5. Dorsal profile of the body is more convex.

6. It is surface feeder, which feed the small crustacean, insects, rotifers algae etc.

7. It take two years to get fully mature, it breed during the month of May to September and lays egg rate of 80,000 to 1,50,000 per kg body weight.

8. This fish mainly found in India, Pakistan, Bangladesh, Myanmar and Srilanks etc.

Mrigal carp *(Cirrhinus mrigala)*

Systematic Position:-

Phylum:	Chordata
Class:	Actinopterygii
Super Class	Pisces
Genus:	Cirrhinus
Species:	***C. cirrhosus***

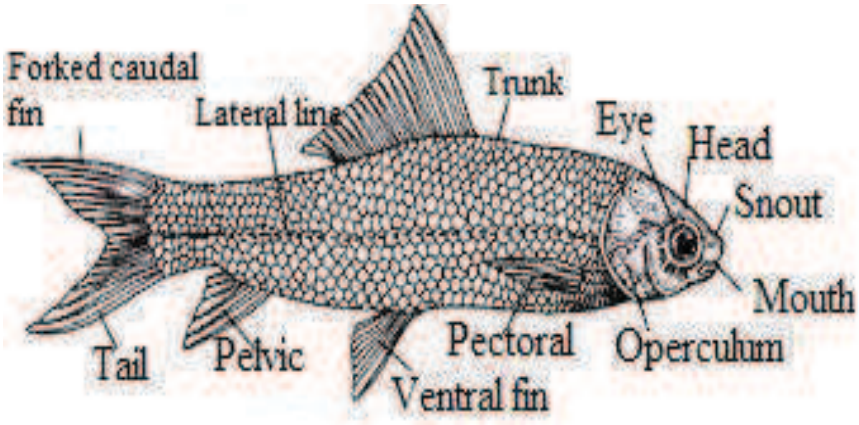


Fig.9.13 Cirrhinus mrigala

1. The **mrigal carp** (*Cirrhinus cirrhosus*, also *Cirrhinus mrigala*, also known as the **mrigal** and the **white carp**.

2. It is a species of ray-finned fish in the carp family.

3. It is Native to streams and rivers in India and the only surviving wild population is in the Cauvery River.

4. It is widely aqua farmed and introduced populations exist outside its native range. It reaches a maximum length of 1 m (3.3 ft).

5. Mrigal is the benthopelagic and potamodromous plankton feeder

6. It inhabits fast flowing streams and rivers, but can tolerate high levels of salinity.

7. Spawning occurs in marginal areas of the water bodies with a depth of 50 to 100 centimeters.

Exotic Carps

Grass Carp *(Ctenopharyngodon idella)*

1. Grass carp is mainly herbivorous but juveniles are omnivorous.
2. Spawns on river beds with very strong current.
3. They can tolerate a wide range of temperature.
4. Occur in lake, pond, pools and rivers etc.

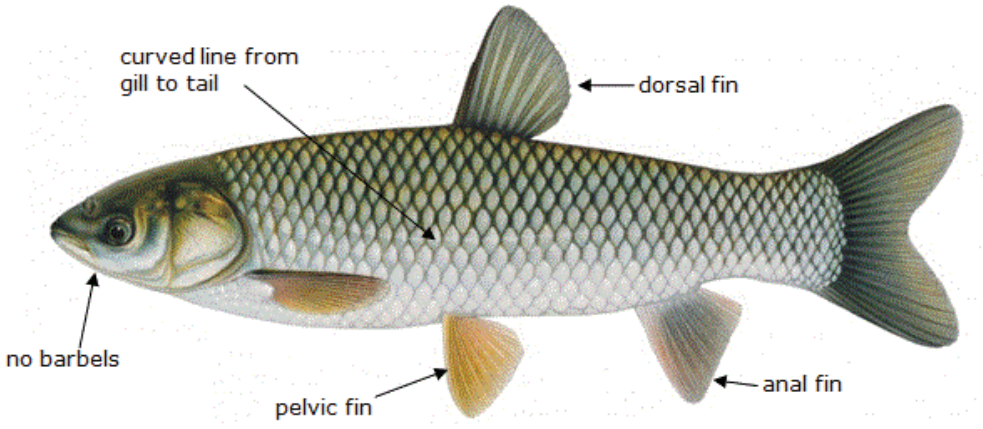


Fig.9.14 Grass carp (Ctenopharyngodon idella)

Common carp (*Cyprinus carpio*)

1. This is known as European carp.
2. Olive green coloration above and yellowish below.
3. Generally fine and fins are often reddish.
4. Body laterally compressed.
5. Body height 1/4 of body length.
6. Triangular head with blunt snout and thik nose plate.

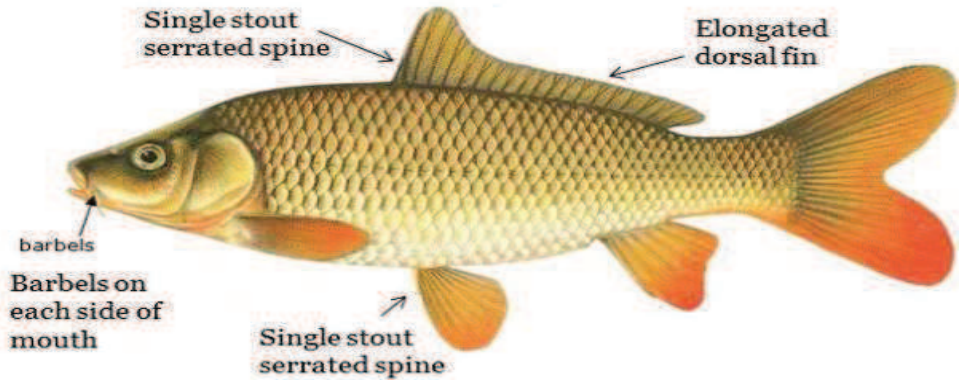


Fig.9.15 Common carp (*Cyprinus carpio*)

Silver carp (Hypophthalmichthys molitrix):-

1. The silver carp (Hypophthalmichthys molitrix) is a species of freshwater cyprinid fish,

2. a variety of Asian carp native to China and eastern Siberia. Although a threatened species in its natural habitat.

3. It has long been cultivated in China. By weight more silver carp are produced worldwide in aquaculture than any other species of fish except for the grass carp.

4. Silver carp are usually farmed in polyculture with other Asian carp, or sometimes with catla or other fish species.

5. The species has also been introduced to, or spread by connected waterways, into at least 88 countries around the world.

6. The reason for its importance was' generally for use in aquaculture, but enhancement of wild fisheries and water quality control have also been intended on occasion.In some of these places the species is considered an invasive species

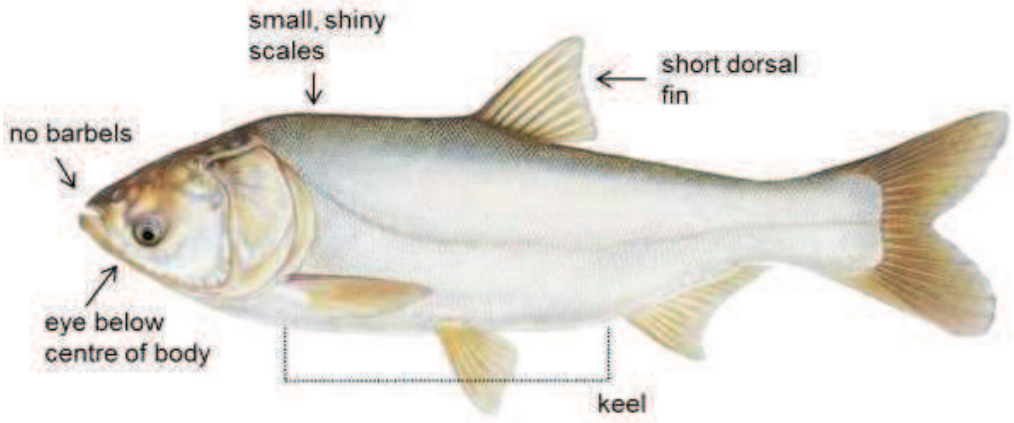


Fig.9.16 Silver carp (Hypophthalmichthys molitrix)

9.6 STORED GRAIN PEST CAPS

In Montana, almost all stored-**grain insects** are **beetles** and **weevils** in the **Order Coleoptera**. There are occurrences of **moth as** pests (**Lepidoptera**). Members of seven other insect Orders are also found in grain storage throughout the world, but the major pests are still primarily from the **Coleoptera** and the **Lepidoptera**.

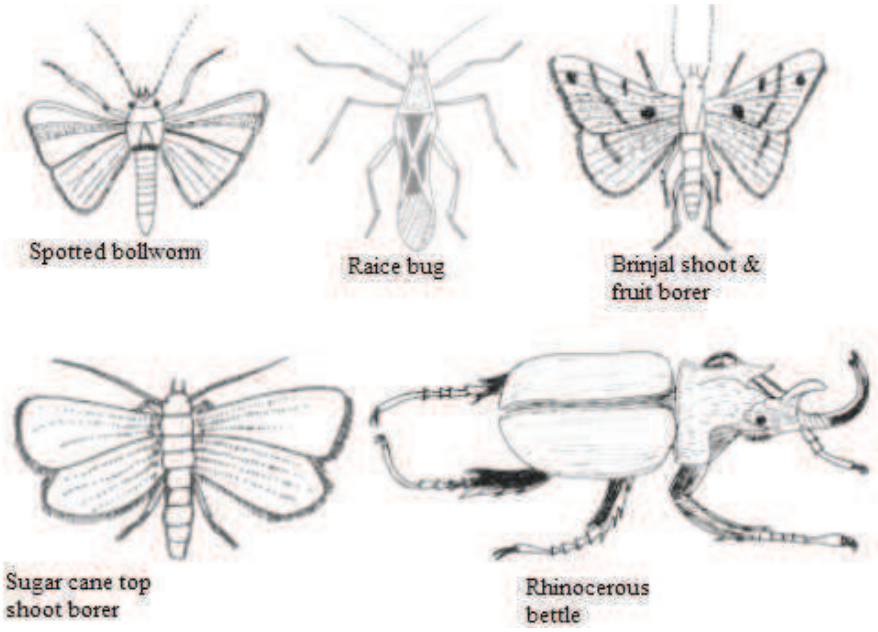


Fig.9.17 Common pests of crops

Some common Stored Grain Pest's

1. Pulse beetle (*Callosobruchus maculates*): It is a species of beetle commonly known as cowpea weevil or cowpea red beetle. It is a member of the leaf beetles family Chrysomelidae hence not a true weevil.

Systematic Position:

Kingdom – Animalia

Phylum - Arthropoda

Class – Insecta

Sub Class-Pterygota

Order – Coleoptera

Family- Chrysomelidae

Genus – *Callsobruchus*

Species – *maculatus*

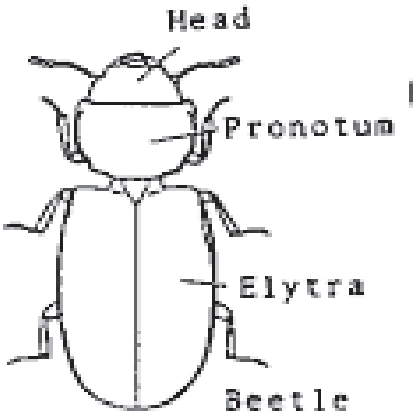


Fig.9.17 Callosobruchus maculates

2. Rice-Weevil (*Sitophilus oryzae*): The rice weevil is a stored product pest of not only rice but almost of all cereals & their products. It is called as rice weevil because it's breeding habits & life-cycle was first of all studied in rice.

Systematic Position:

Kingdom – Animalia

Phylum - Arthropoda

Class – Insecta

Sub Class- Pterygota

Order – Coleoptera

Family- Curcuilionidae

Genus – *Sitophilus*

Species – *oryzae*

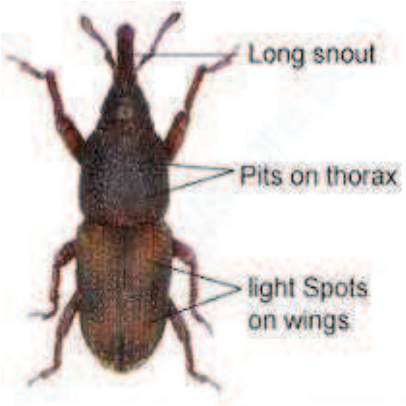


Fig.9.18 Sitophilus oryzae

3. Wheat Weevil (*Trogoderma granarium***):** The pest is cosmopolitan in distribution; it is also called as cabinet beetle. It initially originated in South Asia, wheat weevil is regarded as the most destructive pest of the grain products & seeds.

Systematic Position:

Kingdom – Animalia

Phylum - Arthropoda

Class – Insecta

Sub Class - Petrygoa

Order – Coleoptera

Family – Desmestidae

Genus - *Trogoderma*

Species – *granarium*

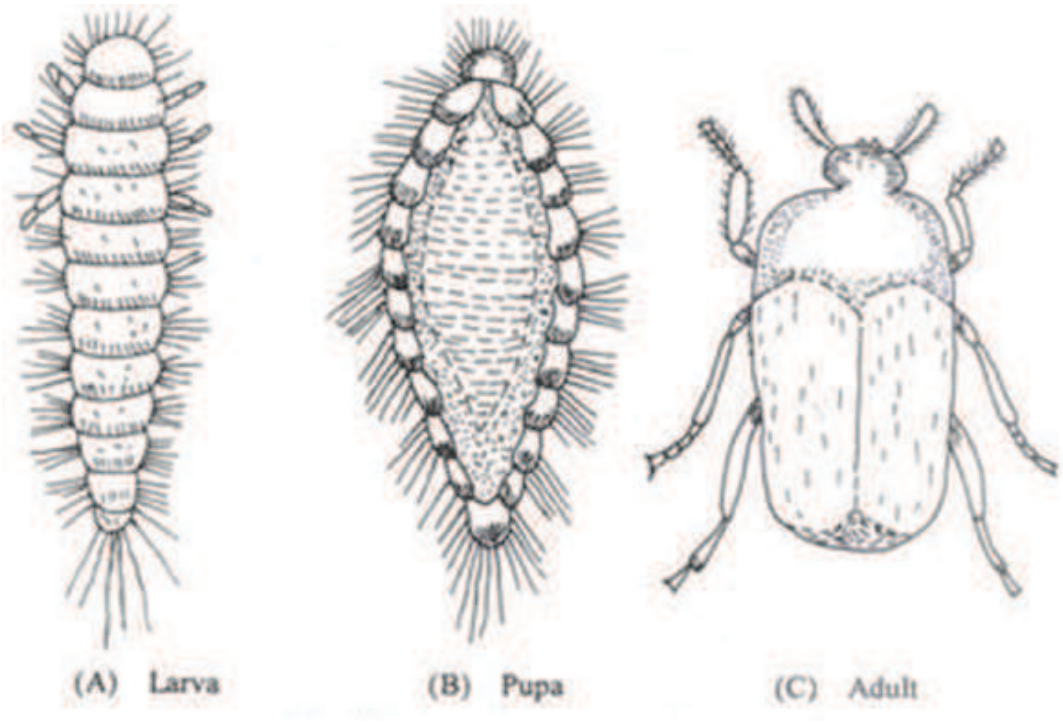


Fig.9.18 *Trogoderma granarium*

4. Rust red flour beetle (*Tribolium castaneum*): The weevil is commonly called as rust red flour beetle, It is cosmopolitan in nature. It initially originated in the Indian Subcontinent but now found throughout all tropical, subtropical and warm temperate regions of the world.

Systematic Position:

Kingdom – Animalia

Phylum - Arthropoda

Class – Insecta

Sub Class - Petrygota

Order – Coleoptera

Family – Tenebrionidae

Genus - *Tribolium*

Species – *castaneum*

Fig.9.19 *Tribolium castaneum*

It is a worldwide serious pest of stored products particularly food grains like flour, cereals, pasta, biscuits, nuts, oil cakes, dried fruits, meal beans, dried pet food, dried flowers, chocolate, seeds, and even dried museum specimens. This beetle is the most important pest of stored products inside the home, food industry & grocery stores. It is different from the confused floor beetle (*Tribolium confusum*) by having different antennae shape & its ability to fly under stressed conditions.

9.7 PICTURE OF ECONOMICALLY IMPORTANT VARIETIES OF POULTRY

Today India is the world's fifth largest egg producer and the eighteenth largest producer of broilers and its per capita consumption of such products is poor - 37 eggs and 1 kg of poultry meat per capita per annum. The growth of the Poultry Industry in India is marked by an increase in the size of the poultry farm.Extra income is obtained from poultry farming at small levels in rural areas and simultaneous use of poultry (feces) is used to make compost for button mushroom production and manure use in kharo as fertilizer increases the productivity of the crop. Use advanced breed seeds, courageous, beneficial, and beneficial developed from central bird research institute , Izzatnagar Bareilly in rural areas. The expense incurred in this adherence to compensate is by selling the poultry in the fifth month. After that, egg production yields good earnings for 12-15 months from the hen. More vermicomposts received during the preparation of Vermi Compost receive more production than giving food to poultry. Similarly, the peacock is also used by poultry. Nearly 40 chickens have the same nutrient content as feces, as they are obtained from a cow dung . Fowls are widely distributed as domesticated animal since times

immemorial. In twentieth century poultry keeping has become an important small scale industry due to modern need for palatable and nutritive food which it provides in the form of eggs as well as adult animals. The storage and transport facilities also have helped to a great extent in its becoming popular as a trade. This naturally has attracted the attention of the people at large and the scientists in particulars necessitating new researches on breeding, hatching and rearing of fowls. India is the native place of the wild jungle fowl but little attention has been paid for developing poultry industry in comparison to other countries. In country like India, the increased egg consumption is essential for the proper nutrition of human beings. The researches carried out at the Imperial Veterinary Research Institute, Izatnagar have demonstrated the high biological value of eggs and recommended the consumption of eggs in supplementing the defective human diets. For the successful management of poultry industry one should have detailed idea about the poultry ground, habitat of fowl, breeds, breeding and rearing of chickens. Though there are-several Government Poultry Farms in India but the poultry is almost entirely in the hands of poor persons, thus eggs available are of small size.

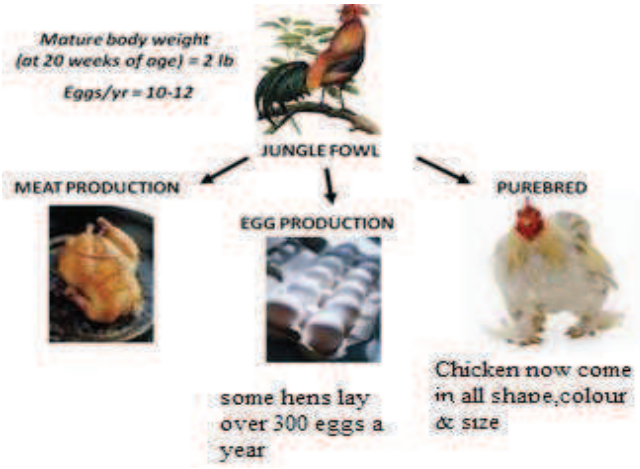


Fig.9.20

Habitat of Fowl

1. Soil. For fowls, soil should be sandy, gravelly and abounding in kunkar alongwith good amount of lime. The stony soil is not suitable for fowls because stones cause damage to feet of the fowl. The heavy soil with high percentage of moisture is harmful. The marshy, dirty and drained grounds are fatal to the animals.

2. Shelter. The poultry should be protected from the cold winds and heavy rains. They should not be allowed to walk in water.

3. Shade. The poultry should be well protected from hot sun and hot wind in summer season, so the site for the poultry ground should be such as to have a number of shrubs and trees. In summer season the west side of the poultry house should be closed in the day time otherwise they will die due to westerly wind. The places where trees are not found, a shed of 10 to 15 square feet should be made with bamboo and straw. The shed should be kept 3 feet above the ground surface with the help of bamboo posts. The ground where such shades are not possible, it may be constructed with metal and raised 2 feet from the ground on stone pillars. The ground beneath the shed should be raised about 3 inches from general surface for good drainage.

9.7.1 PARASITES/SLIDE STUDY

9.7.1.1 Parasites/Slide study of Trypanosomes & E.histolytica

Systematic position:

Phylum: Protozoa

Subphylum: Sarcomasigophora

Super class: Mastigophora

Class: Zoomastigophora

Order: Kinetoplastida

Genus: *Trypanosoma*

Species: *gambianse*

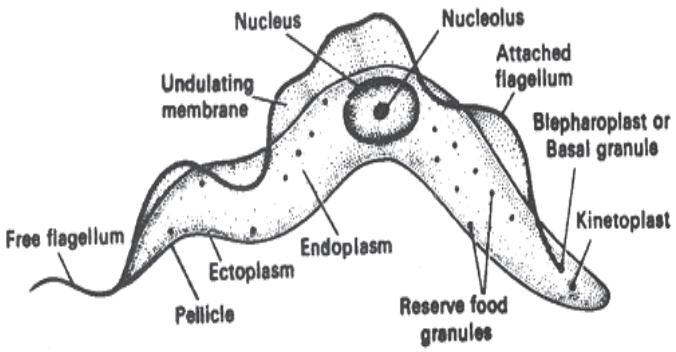


Fig.9.21 Trypanosoma

Distribution:-

It is found in Africa and America. It has been reported from India also.

Comments

- Unicellular, microscopic, simple animal commonly found in Africa.
- It is an endoperasite found in blood and other tissues of man and other vertebrates. It causes Trypanosomiasis or Sleeping sickness.
- It is digenetic i.e. it completes its life cycle in two host:principal host in man and intermediate host is a blood sucking insect Glossina palpalis or Testse fly.
- It is a polymorphic species exists in man and a crithidial forms in testse fly
- A single flagellum arises from a basal body placed near the posterior end
- Reproduction take place by longitudinal binary fission

Host:

It is an endoparasite in blood and tissues of man and other vertebrate's like Pig, Buffaloes and antelopes etc; which are its reservoir hosts.

Symptoms of the Disease:

Several species of trypanosome are known *T.cruzi* cause Chagas disease, *T.brucei* causes Nagana disease but *T. gambiense* and *T.rhodesiense* causing sleeping sickness are by farther most important and well known among the trypanosome species. The parasite invades the cerebrospinal fluid resulting in a recurrent fever. The patient become weak, anemic and loses weight. Strong tendency to fall asleep is observed in the Initial stages and can lead to coma and death if untreated**.**

ENTAMOEBA HISTOLYTICA

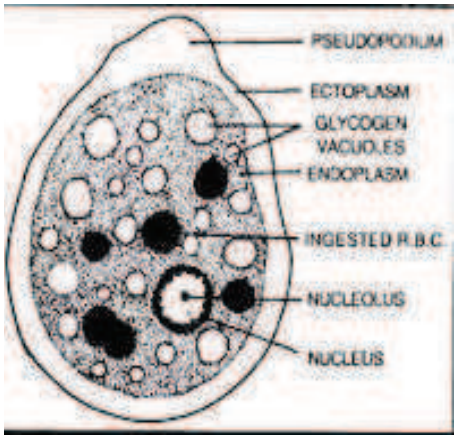


Fig. 9.22 Entamoeba histolytica

CLASSIFICATION

Phylum protozoa

Sub phylum Sarcomastigophora

Class Rhizopoda

Order Lobosa

Genus *Entamoeba*

Species *histolytica*

Distribution:-

Entamoeba histolytica is worldwide in distribution, but its prevalence is greater in tropics and subtropics than in the temperate zones. It has been reported that incidence of infection is high in Mexico, China, India and parts of South America.

Habits and Habitat:-

Entamoeba histolytica is a microscopic endoparasite of man .it is commonly found in the upper part of the large intestine and is very often lodged in the river, lungs, brain and testes.

Commment:-

- *Entamoeba histolytica* is a small microscopic parasitic *Amoeba* .in its life cycle, it occur in three distinct forms.
- Trophozoite or magna form.

- Precystic or minuta form.
- Cystic forms.

9.7.1.2 Parasites/Slide study of Leishmania & Giardia

Classification:-

Phylum: Protozoa

Subphylum: Sarcomastigophora

Class: Zoomastigophorea

Order: Kinetoplastida

Family: Trypanosomatidae

Genus: *Leishmania*

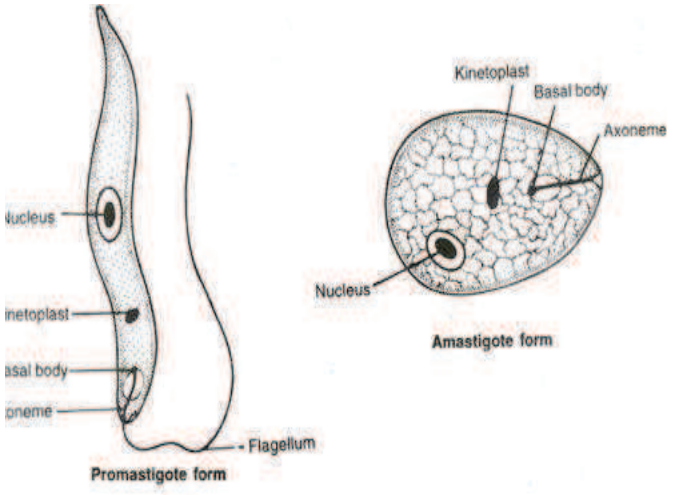


Fig. 9.23 Leishmania

Distribution:-

It is found as an intracellular parasite in Leucocytes and cells of liver, spleen, bone marrow, etc.

Morphology and Life Cycle:-

- *Leishmania* spp. are digenetic or heteroxenous parasites, whose life cycle involves two
- Hosts, a vertebrate and an invertebrate, the sandfly
- Hemoflagellates may have several morphological stages that differ from one another in the placement of the kinetoplast relative to the nucleus, as well as the location and origin of the flagellum3
- In *Leishmania* the life cycle stage in the vertebrate is the amastigote and in the insect, the promastigote. *Leishmania* exist in two basic body forms
  (a) The amastigote, the intracellular form in the vertebrate host, and
  (b) promastigote, the extracellular form in the sandfly (*Phleobotomus* spp and *Lutzomyia* spp.) Vector
- Amastigotes are taken up from the blood of an infected host when the female sandfly bites, and in the sandfly gut they develop into promastigotes where they multiply by binary fission; promastigotes move anteriorly into the proboscis, and are introduced into the vertebrate host when the sandfly bites again. 5
- The promastigotes injected by the sandfly during feeding are phagocytized and develop into intracellular amastigotes.
- The amastigote, literally "without a flagellum," is the intracellular, non-motile form in the vertebrate host, and it divides by longitudinal binary fission at 37^{o}C. Intracellular zamastigotes are 3-6 um in length and 1.5-3.0 um in width.7
- The amastigote is also called the Leishman-Donovan (LD) body. The amastigote is not really devoid of a flagellum, it is simply that the flagellum does not protrude beyond the body surface and by light microscopy cannot be seen.

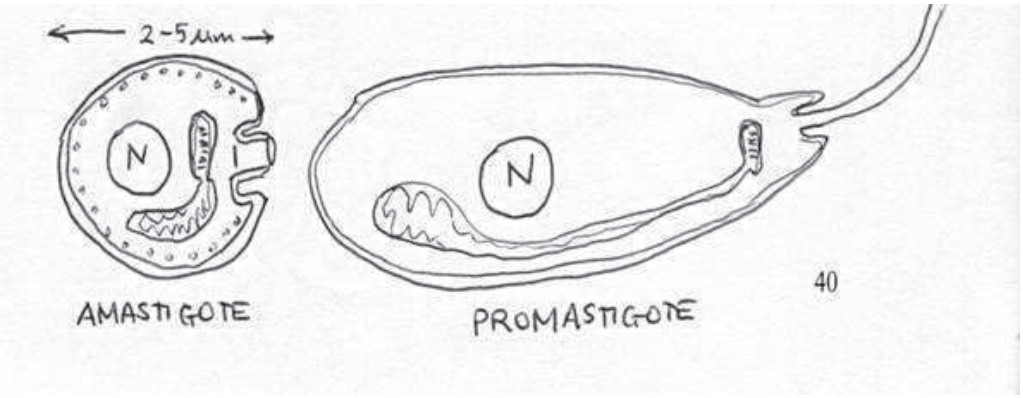


Fig.9.24 different stage of Leishmania

- The promastigote, literally the body form with "an anterior flagellum" is 15-30 um in body length and 5mm in width.

- it is extracellular, motile, and grows and divides by longitudinal binary fission at 27^{o}C in the sand.

1. Soon after entering the gut, the amastigotes get coated with peritrophic matrix, which is composed of chitin and protein complex. This protects the parasites from the digestive enzymes of the host.
2. The amastigotes travel as far as the abdominal midgut and first transform into a weakly motile "procyclic promastigotes" on the gut wall within 1–3 days.
3. The young promastigotes secrete a neuropeptide that stop peristalsis of the gut. The surface lipophosphoglycan (LPG) of the promastigote serves as an attachment to the gut epithelium. These factors prevent the expulsion of promastigotes during excretion of the insect.
4. During 4–7 days the peritrophic matrix is degraded by the activity of chitinases. This release the more actively motile "nectomonad promastigotes" which migrate anteriorly until they reach the opening of the thoracic gut.
5. Another transformation takes place by which they turn into "leptomonad promastigotes". These are fully motile and capable of binary fission. Multiplication and migration towards thoracic midgut cause congestion of the pharynx and buccal cavity.

6. Here they secrete promastigote secretory gel (PSG), which is composed of soluble acid phosphatase and phosphoglycoprotein.
7. After 6–9 days the promastigotes become metacyclic. Some are also transformed into Non-replicating promastigotes, which also become metacyclic. The sandfly is able to regurgitate and eject the parasites from its proboscis with the help of PSG when it bites.

Giardia:-

Classification

Phylum Protozoa

Subclass Sarcomastigophora

Class Zoomastigophora

Order Diplomonadida

Genus *Giardia*

Species Lamblia

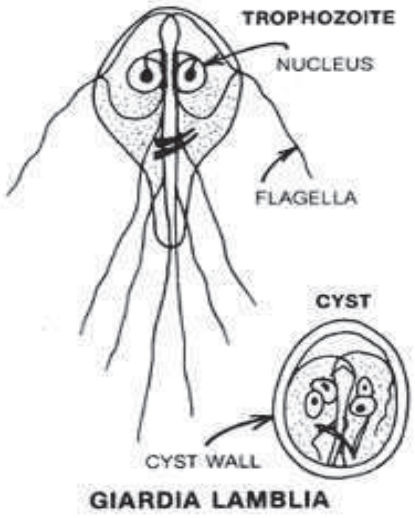


fig.9.25

Comments:-

- It lives in the intestine of man as an endoparasite and cause **Giardiasis**
- It has two nuclei and bears four flagella on either side of the body
- It feeds on vitamins and amino acids contained in food within the intestine.
- Giardia intestinalis trophozoites are pear-shaped and 10–20 µm long.
- Other characteristics include: flagella, median bodies, sucking disks and two big nuclei. Giardia intestinalis cysts are oval to ellipsoid and 8–19 µm long
- Immature cysts have two nuclei, whereas mature cysts have four.

Causal Agent:-

Giardia intestinalis is a protozoan flagellate (Diplomonadida). This protozoan was initially named *Cercomonas intestinalis* by Lambl in 1859. It was renamed *Giardia lamblia* by Stiles in 1915 in honor of Professor A. Giard of Paris and Dr. F. Lambl of Prague. However, many consider the name, *Giardia intestinalis*, to be the correct name for this protozoan. The International Commission on Zoological Nomenclature is reviewing this issue.

Life Cycle:-

Cysts are resistant forms and are responsible for transmission of giardiasis. Both cysts and trophozoites can be found in the feces (diagnostic stages)

- The cysts are hardy and can survive several months in cold water. Infection occurs by the ingestion of cysts in contaminated water, food, or by the fecal-oral route (hands or fomites)
- In the small intestine, excystation releases trophozoites (each cyst produces two trophozoites)
- Trophozoites multiply by longitudinal binary fission, remaining in the lumen of the proximal small bowel where they can be free or attached to the mucosa by a ventral sucking disk.
- Encystation occurs as the parasites transit toward the colon. The cyst is the stage found most commonly in non-diarrheal feces.
- Because the cysts are infectious when passed in the stool or shortly afterward, person-to-person transmission is possible. While animals are infected with *Giardia Lamblia*, their importance as a reservoir is unclear.

9.8 REFERENCES

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3. Rastogi V.B. (1999) Lower non-chordate & Economic Zoology.

4. Some text material fig is adopted from Wikipedia.

5. Jordan E.L., (2015) Invertebrate Zoology.

6. Agarwal V.K., (2014) Zoology for Degree Student.

9.9 PRACTICAL WORK RELATED EXERCISES

(Total marks 50)

1. Spotting – 10 spots write comments only (2 marks for each) (20 marks)

(Entamoba histolytica, Trypanosome, Leishmania, Giardia, Labeo rohita, Cutla cutla, Cirrhinus mrigala, Grass carp, Silver carp, Rice weevil, Pulse beetle, Redflour beetle, White leghorn,.)

2. Life cycle of anyone (10 marks)

(Apis, Slik moth, Lack insect)

3. Write comments on any one- (5 marks)

Poultry and its products, Apiculture, Sericulture and lack culture

4. Viva Voce (5 marks)

5 Record and Collection/Field report (10 marks)